THE MALAYAN JOURNAL

OF

TROPICAL GEOGRAPHY

VOLUME FOUR

JANUARY 1955

MINING LANDSCAPES OF KINTA

By

OOI JIN-BEE, M.A.

Printed with a grant from the Lee Foundation and by the generosity of Mr. Lee Kong Chian of Singapore

PUBLISHED BY THE DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF MALAYA, SINGAPORE

SPECIAL ISSUE

This volume
is an abridgment of a thesis
presented for the degree of Master of Arts
in the University of Malaya,
June 1954

CONTENTS

	Page
Tin-mining landscape near Senlu, Perak	*Frontispiece*
List of Maps and Diagrams	ii
List of Tables	ii
Preface	iii
Chapter I THE EXTRACTION OF TIN ORE	
(1) THE PHYSIQUE OF THE KINTA VALLEY	1
(2) MODES OF OCCURRENCE AND DISTRIBUTION OF TIN ORE ..	2
(3) MINING METHODS (i) Primitive Mining	6
(ii) Malay Mining	7
(iii) Chinese Mining	8
(iv) Modern Mining	9
(4) THE PATTERN OF MINING LAND USE	13
II WATER AND CLIMATE	
(1) THE PROBLEM OF EXCESS WATER	16
(2) SWAMP MINING	18
(3) THE EFFECT OF WEATHER ON MINING	19
III ACCESSIBILITY AND TRANSPORT	
(1) WATER TRANSPORT	21
(2) THE EARLY ROAD SYSTEM	23
(3) THE KINTA VALLEY RAILWAY LINE	25
(4) THE PRESENT TRANSPORT NETWORK	26
IV THE EXHAUSTION OF RESERVES	
(1) REJUVENATION THROUGH TECHNICAL IMPROVEMENTS ..	28
(2) THE RATE OF EXHAUSTION	29
(3) PROSPECTING	31
(4) POTENTIAL RESERVES	32
V EROSION AND SILTING	
(1) DAMAGE BY MINING	34
(2) METHODS OF CONTROL	35
(3) DAMAGE FROM AGRICULTURAL ACTIVITIES	36
(4) RIVER CONSERVANCY SCHEMES	39
VI MINING AND OTHER FORMS OF LAND USE	
(1) MINING AND AGRICULTURE	41
(i) Reclaiming Mined Land	43
(ii) Padi Experiments	45
(2) MINING AND FORESTRY	46
(i) Forest Reserves	47

	Page
VII POPULATION DISTRIBUTION AND RESETTLEMENT	
(1) The Urban Population	49
(2) The Rural Population	52
(3) The Effects of Re-location on Mining	55
Bibliographical Note	57

LIST OF MAPS AND DIAGRAMS

Fig.	1. The Kinta Valley: A. Relief	
	B. Drainage	1
	2. Geological Map of the Kinta Tin-field	4
	3. Vertical Section showing Limestone Pinnacles Projecting upwards into Alluvium	5
	4. Distribution of Mines in the Kinta District, July 1953	14
	5. Diagrammatic Section to show the Working of a *chin-chia*... ...	18
	6. A. The Distribution of Mines and the Pattern of Communications in the Kinta Valley, 1885	
	B. The Communications Network in the Kinta Valley, 1901 ...	24
	7. The Communications Pattern in the Kinta Valley, 1953	27
	8. Key Plan of the *Kinta River Deviation*	38
	9. Transverse Section showing the Proposed form of the Channel of the Kinta River	39
	10. Land Alienation in the Kinta District, 1951	42
	11. Settlement changes in the Kinta Valley, 1947–52	
	A. Towns and Villages in 1947	
	B. New Settlements, 1952	53

LIST OF TABLES

Table	1. The Geological Sequence in the Kinta Valley	2
	2. Modes of Occurrence of Tin Ore in Kinta	3
	3. Production of Tin Ore in Kinta, 1952, according to Methods of Mining	13
	4. Dredging Companies in Kinta in 1927, with their Estimated Ore Reserves	30
	5. Population and Racial Composition of Towns in Kinta, 1947 ...	50
	6. Immigration into Telok Anson, 1879–94	50
	7. Population of Kinta, 1879–1947	51
	8. Resettlement Villages in Kinta District, 1952	54
	9. Resettlement Villages within Town Board Limits, 1952	55

The maps in this volume have been drawn by Mr. Poon Puay Kee

PREFACE

This dissertation does not attempt to describe *in toto* the various features of the Kinta Valley landscape in the manner usually associated with a regional study. Rather is it an examination of the main environmental problems which affect mining in that area and of the solutions that have been, or are being, attempted by various cultural groups. The first four chapters are an analysis of the major physical difficulties with which the miners have had to contend, the last three deal with the repercussions on the valley landscape of the several mining techniques employed. Yet in the sum this method of approach has yielded much the same result as would a more conventional regional synthesis, with possibly a sounder understanding of those complex features which serve to particularize the Kinta Valley, and thus to establish its geographical personality. In dealing with these themes I have not scrupled to employ where necessary the technique of the historical geographer, not merely to gratify an antiquarian interest, but in the belief that a landscape can only be fully understood in the light of its evolution. As the geomorphologist must have some acquaintance with preceding physical geographies, so must the student of the humanized landscape either ignore relict features or inform his studies with a knowledge of their origin.

From time to time I have discussed the several aspects of this work with experts and laymen in both the Federation of Malaya and Singapore, all of whom have in greater or lesser measure subscribed to the fashioning of my ideas on the subject. It is impossible at this stage to separate the metal of their individual contributions from the final amalgam of my thought, but I wish to place on record my heavy indebtedness to these anonymous, and often unwitting, helpers. I must also acknowledge the assistance I have received from several Government departments. Mr. Harold Service, Director of the Geological Survey of the Federation of Malaya, not only allowed me to use his Departmental Library, but also provided me with a revised map of the geology of Kinta. Both the general editor and I benefited from discussions with him and with Mr. E. F. Bradford of the Geological Survey in Sungei Patani. Mr. Bradford also kindly read the typescript and offered pertinent comments. To the Director of the Drainage and Irrigation Department of the Federation of Malaya, I am indebted for the preparation of Figs. 8 and 9. Mr. G. F. Gripper, the Chief Inspector of Mines, provided me with much relevant material, including the typescript of Mr. W. E. Everitt's *A History of Mining in Perak*, while Mr. D. R. Mitchell of Anglo-Oriental (Malaya), Ltd. tendered valuable criticisms which have been incorporated in the final draft. Dr. C. A. Gibson-Hill kindly provided the frontispiece. In addition I received liberal help from Mr. W. L. Stapleton, Acting Senior Inspector of mines; Mr. E. A. Somerville, the District Officer of Kinta; Mr. Y. C. Foo of Ipoh and Mr. L. J. Peace, Secretary to the Chamber of Mines. But the greatest measure of thanks must be reserved for Dr. E. H. G. Dobby, Professor of Geography in the University of Malaya, whose advice, extending not only over the period of this dissertation but throughout my undergraduate days as well, has been invaluable at all times. For any errors that may remain the responsibility must, of course, rest with me alone.

OOI JIN-BEE.

21st October, 1954.

CHAPTER I

THE EXTRACTION OF TIN ORE

The Physique of the Kinta Valley

The kinta valley lies between two granite masses: on the west is the Kledang Range, about twenty-five miles long, averaging two miles in width and reaching a maximum height of 3,496 ft., while to the east is that part of the Main Range which lies between Gunong Kerbau (7,160 ft.) and Gunong Pergantong (4,740 ft.). The valley is triangular in shape,

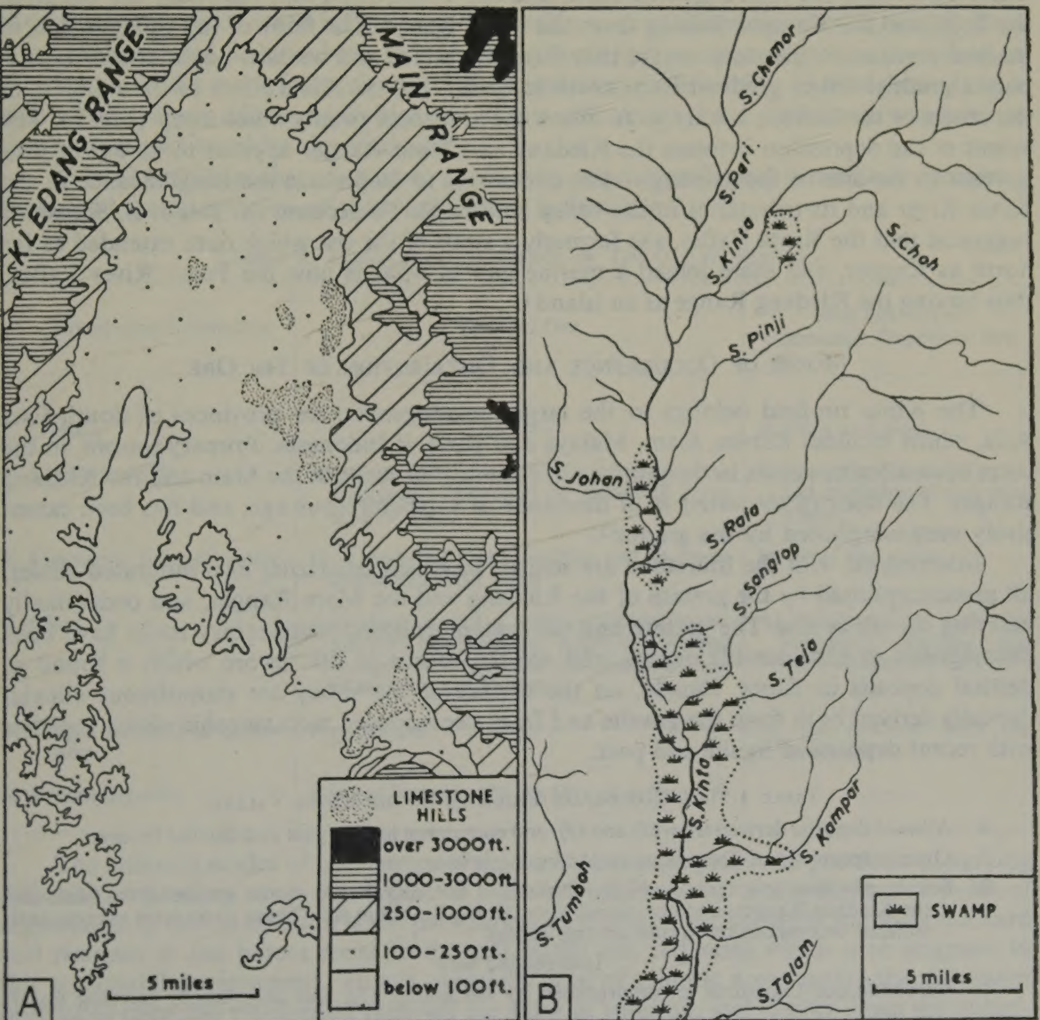

Fig. 1. The Kinta Valley.

A. Relief. B. Drainage.

Both maps are based on *Hind 1076*, 1: 253,440, Sheets *2M* and *2N*, First Edition.

with the northern apex of the triangle formed by the rising ground north of Chemor town, and the broad base extending westwards from Gunong Kinjang (4,780 ft.) to the Sungei Tumboh. At its narrow northern end the valley is only six miles wide, but it fans out southwards until between Pusing and Gopeng it attains a width of more than twelve miles (Fig. 1A). A striking feature of the valley landscape is the presence of a number of limestone cliffs with steep faces, which rise abruptly from the general level of the countryside. They are found only on the eastern side of the Kinta River, where they form seven distinct masses, with the largest, including Gunong Gajah, Gunong Jasi and Gunong Tempurong, forming a range more than four miles long.

This valley is drained by the Kinta River system, which is itself tributary to the Perak River (Fig. 1B). The main affluents of the Kinta are the Pari, the Johan, and the Tumboh, which flow from the Kledang watershed, and the Choh, the Pinji, the Raia, the Sanglop, the Teja, and the Kampar flowing from the Main Range. The floor of the valley is flat, in marked contrast to the steep ranges that form its eastern and western boundaries. There is only a gradual fall in gradient from north to south, and the Kinta River at Batu Gajah, in the centre of the district, is only 67 ft. above the sea, some twenty miles away (Fig. 8). The extent of the depression between the Kledang and Main Ranges appears to be out of proportion to the size of the existing rivers, and serves to emphasize the insignificance of the Kinta River and its tributaries in the valley landscape. To account for this J. B. Scrivenor suggested that the Kinta Valley was formerly a strait of the sea which once extended as far north as Enggor, and there joined a marine gulf in what is now the Perak River Valley, thus leaving the Kledang Range as an island[1].

Modes of Occurrence and Distribution of Tin Ore

The Kinta tin-field belongs to the large metallogenetic tin province[2] of South-East Asia, which includes Burma, Siam, Malaya and parts of Indonesia. Primary tin-ore, in the form of cassiterite, occurs in the granites and associated rocks of the Main and the Kledang Ranges. The floor of the valley is of limestone of Carboniferous age, and has been extensively metamorphosed by the granite[3].

Interbedded with the limestone are schists, phyllites, quartzites and indurated shales, all metamorphosed by the granite of the Kledang and the Main Ranges, and occasionally carrying tin-ore *in situ*. The granite and the metamorphosed sedimentary rocks have been decomposed to considerable depths, and are the source of the tin-ore which is found as detrital deposits in Kinta. Finally, on the surface of the valley are stanniferous alluvial deposits derived both from the granite and from decomposed metamorphic rocks, together with recent deposits of lignite and peat.

Table 1: The Geological Sequence in the Kinta Valley

4. Alluvial deposits derived from (2) and (3), and containing lignite, peat and detrital tin-ore.
3. Granite (probably of Cretaceous age), carrying primary tin-ore.
2. Schists, phyllites, quartzites and indurated shales metamorphosed by the granite of the Main and the Kledang Ranges, and occasionally containing tin-ore *in situ*. These rocks have subsequently suffered decomposition to considerable depths.

Interbedded with

1. Carboniferous Limestone metamorphosed by the granite (3), and occasionally carrying tin-ore *in situ*.

1. J. B. Scrivenor, *The Geology of Malayan Ore-Deposits* (London, 1928), pp. 49, 188–9.
2. A *metallogenetic tin province* is defined by W. R. Jones as an area whose primary tin deposits have all been formed at the same period of mineralization—*Tinfields of the World* (London., 1925), p. 65.
3. The age of the granite has not been definitely established, but it is thought to be of Cretaceous origin—F. T. Ingham and E. F. Bradford, *The Geology and Mineral Resources of the Kinta Tinfield, Perak* (in the press).

Tin-ore may be said to be ubiquitous in Kinta, so that only a very small percentage of the total area of the Kinta Valley is free from the threat of mining. Regions unlikely to be required for mining are areas that have been built up or reserved for one reason or another, and I propose to use the term *non-stanniferous* as conveniently describing them, even though tin may be found in these localities.

According to Scrivenor, tin-ore in the Kinta Valley does not only occur as simple detrital deposits washed down the flanks of the two granite ranges. He claims that the ore is found in all the rock formations that make up the geological sequence of the valley, including the granite hills, the limestone hills, the limestone bedrock, the decomposed metamorphic rocks, and the recent alluvial deposits[1]. He has divided the tin-bearing deposits into two main classes: (1) detrital deposits, which include all the sources of tin-ore (i) where the cassiterite has been deposited mechanically after removal from the position it originally occupied when it first came into being as crystallized tin-dioxide, or (ii) where it can only be said to have been moved from its original position without subsequent deposition, as in the case of deposits affected by soil-creep on hill-sides; (2) non-detrital deposits, which include all those in which the tin-ore still occupies the position in which it was originally precipitated by chemical action[2].

Table 2 correlates these two types of deposits with the geological formations containing them, and the distribution of these formations is shown in Fig. 2.

TABLE 2: MODES OF OCCURRENCE OF TIN ORE IN KINTA[3]

Containing Formation	Detrital Ore	Non-Detrital or Chemically Deposited Ore
1. Granite	———	In veins and pipes.
2. Limestone hills ..	In caves, and in one case in a fault-fissure. Frequently cemented by calcite to form a hard rock	Reported in Gunong Lanno, and probably occurs elsewhere.
3. Limestone floor of valley	In a modified pipe in Lahat and in caves associated with pipes	In pipes and veins.
4. Clays	Abundant, if not a constant, constituent. Derived not from the Main or Kledang Ranges but from some old granite, the site of which is not known	At the junction with the younger(?) granite and veins connected with it.
5. Shales, schists and quartzites	Not proved	At the junction with the the granite.
6. Recent deposits ..	Derived from (1), (2), (3), (4) and perhaps (5)	———

The different modes of occurrence of tin ore have always presented problems of varying difficulty, depending upon the degree of technical achievement of the miners. A point of importance in this connection is the part played by tropical weathering in reducing the hard and resistant *in situ* parent rocks to the soft, easily cut, red earth which is so common in this equatorial environment. This is especially true of granitic areas where the dominant process of chemical weathering removes the silica in solution, and breaks down the constituents of the rocks. The importance of this process in mining is well brought out by

1. J. B. Scrivenor, *The Geology and Mining Industry of the Kinta District, Federated Malay States* (Kuala Lumpur, 1913), p. 71.
2. J. B. Scrivenor, *Notes on Prospecting for Tin-ore in the Federated Malay States* (Kuala Lumpur, 1911), p. 3.
3. Based on Scrivenor, *The Geology and Mining Industry of the Kinta District*, p. 72.

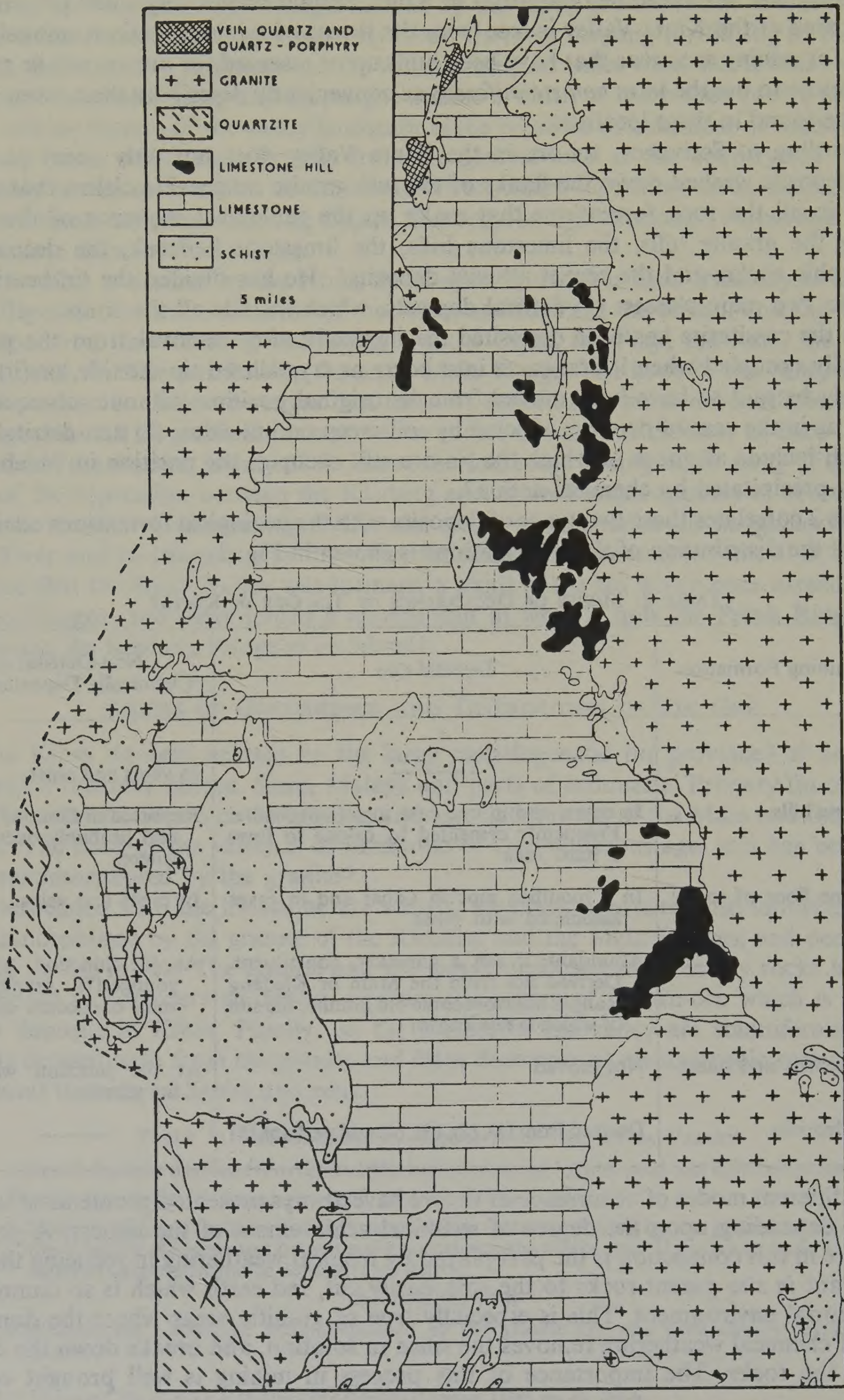

Fig. 2. Geological map of the Kinta tin-field. Re-drawn from a map provided by the Geological Survey Department of the Federation of Malaya.

Scrivenor: "In Kinta and elsewhere there is good reason for believing that had not the rocks been so affected, much of the mineral wealth would have had to remain as an unrealizable asset, the costs of winning the tin-ore being prohibitive"[1].

Although processes of chemical weathering have made most of the tin-bearing rocks easier to break down for the recovery of tin-ore, the effect of ground-water on the limestones of the valley has had the opposite result, making the recovery of tin-ore increasingly difficult. Limestone is easily soluble in ground-water, especially when it is fissured by fault-planes, bedding planes, and cleavage planes as in the Kinta Valley. The effect of solution is to hollow out and enlarge such fissures to form cups or trough-shaped cavities into which overlying alluvial beds sink. The continuous percolation of ground-water gradually deepens the cavities, and it is usual to find long, deep solution troughs in the limestone which flanks the west of the valley, as well as in the limestone floor. Occasionally one of these troughs is exposed by mining excavations, as has happened in the Siputeh Tin Mines. The solution of the limestone does not take place evenly over the whole surface. It is most pronounced in the zones of weakness which are first subject to attack from ground-water, so that in time, as irregularities become accentuated, innumerable pinnacles are formed projecting up into the overlying clays. This creates a prospecting problem, for the concentration of ores in the cavities may give a false idea of the richness of the ground (Fig. 3). Apart from this,

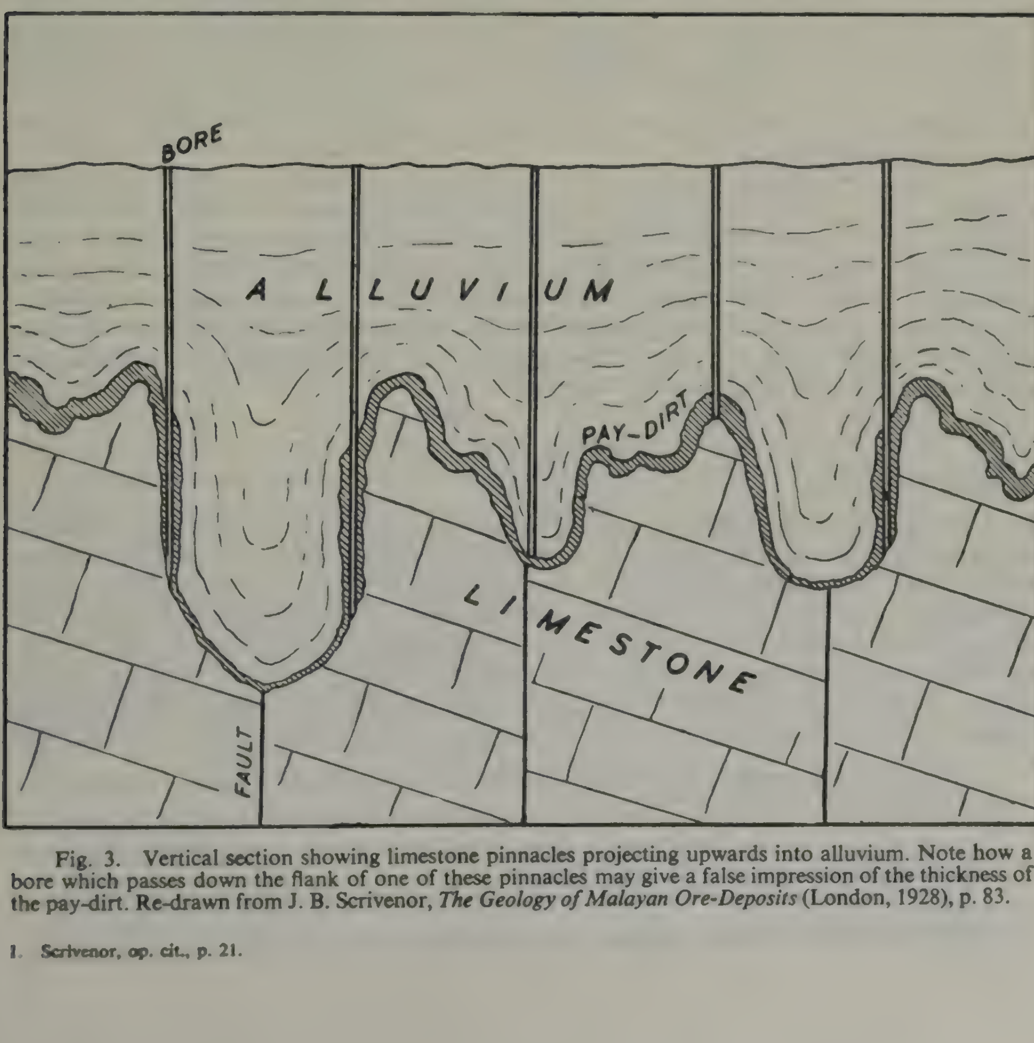

Fig. 3. Vertical section showing limestone pinnacles projecting upwards into alluvium. Note how a bore which passes down the flank of one of these pinnacles may give a false impression of the thickness of the pay-dirt. Re-drawn from J. B. Scrivenor, *The Geology of Malayan Ore-Deposits* (London, 1928), p. 83.

1. Scrivenor, op. cit., p. 21.

the nature of the limestone surface poses a problem in the extraction of the tin-ore lying between the pinnacles. Dredging is difficult because the buckets cannot, at any angle, scrape these surfaces clean of the tin-bearing wash[1].

Limestone near the granite margins may contain veins and pipes of tin-ore, sometimes as angular grains cemented by re-crystallized calcite. From the technical point of view these are residual deposits, as a complete removal of the containing rock may be effected by solution, but in most cases they are mined by alluvial methods. They present practical difficulties in their extraction, for most of the veins and pipes are small and not persistent in depth. In pipes, the only way of estimating the amount of tin-ore present is to remove the whole of it by continuous shaft-sinking, while the only "ore in sight" is that at the bottom of the shaft[2]. Many pipes and veins also contain metallic sulphides such as arsenopyrite with the ore, which necessitates preliminary roasting before it can be smelted.

The alluvium of Kinta contains a high percentage of clay derived from two main sources: kaolin brought down from the granite hills, and fine detritus from weathered shales and schists. This is a disadvantage to miners, as the presence of heavy clay increases the difficulty of thoroughly mixing the pay-dirt with water, which is the method of separating the ore from the other waste materials.

The commonest constituent of tin-bearing ground in West Kinta is a sandy clay, interstratified with beds of sand and sometimes of gravel. In East Kinta the ground is more sandy with less clay, and also more gravelly. These deposits are all largely unconsolidated and lack distinct bedding planes. Consequently, the tin-sand, instead of being concentrated in well-defined beds, is distributed in irregular values throughout the whole thickness of the deposits, and this irregularity has been further complicated by the piping of the clays into the limestone surface[3].

The sinking of alluvial deposits overlying the limestone has also led to the formation of swamps, with the result that beds of lignite and peat are common[4]. In the present landscape of the valley a large stretch of swamp occurs from a little to the north of Batu Gajah southwards to the mouth of the Perak River (Fig. 1B). The recovery of stanniferous ore from these naturally repellent areas was a major problem in the early days of mining in Kinta, and it was not until the beginning of the present century and the introduction of the highly specialized mining technique of dredging that the practical difficulties of extracting ore from these areas was successfully overcome.

Mining Methods

(1) *Primitive Mining*

Local tradition has it that long ago the Siamese were the principal miners in Kinta[5], but this would have been impossible. However, stream-tin was worked for several centuries before the Chinese came to this region in the nineteenth century. In 1886 a French mining company found at least fifty well-like pits, averaging eight feet in diameter and some twenty feet in depth, in Lahat Hill[6]. In these early mines, called *lombong siam* by the Malays, water was a major problem, for seepage restricted the depth to which they could be worked. There is no evidence that any means of baling was devised, and mining was apparently confined to those places with a free natural drainage, usually hill slopes[7]. The shafts had

1. G. H. Hutton, "Selected Phases of the Evolution of the Tin-Mining Industry", *Federated Malay States' Chamber of Mines Year-Book, 1931* (Kuala Lumpur, 1931), Appendix L, p. 176.
2. J. B. Scrivenor, *The Deposits of Tin-ore in the Limestone of the Kinta Valley, Federated Malay States* (Kuala Lumpur, 1914), p. 18.
3. E. S. Willbourn, "A Short Account of those Tin-deposits in Kinta that are Mined by Alluvial Methods", *Journal of the Mining Association of Malaya*, Vol. 4, No. 4 (Dec., 1936), p. 258.
4. Scrivenor, *The Geology of Malayan Ore-Deposits*, pp. 191–2.
5. A. Hale, "On Mines and Miners in Kinta, Perak", *Journal of the Royal Asiatic Society, Straits Branch*, Vol. 16 (Singapore, 1886), p. 303.
6. Hale, op. cit., p. 304.
7. W. E. Everitt, *A History of Mining in Perak* (Ipoh, 1952), p. 2 [Typescript].

no timber supports and so excavation was restricted to the topmost layers of *karang*[1]. The greatest depth that could be reached under the most favourable conditions was 30 ft.,[2] and consequently, horizontal mining was of more importance than vertical. This method, therefore, consisted in the excavation of large areas of land containing shallow deposits of ore located at or just below the surface, instead of the working of progressively deeper layers of ore on one site.

(2) *Malay Mining*

The Malays were cultivators and fishermen living in riverine *kampongs*. There is no definite evidence to show how they acquired their knowledge of mining or when they first began. Everitt thought that they learnt their technique from the descendants of early Indian settlers in Malaya[3], but this idea is no longer tenable. Evidence of old Malay workings was found in Lahat Hill in the shape of tin ingots, each cylindrical at the base and tapering to a six or eight-sided upper portion[4]. But mining never entirely superseded the traditional Malay economy, and was nearly always a part-time occupation, undertaken only after the harvest had been gathered.

The recovery of tin-ore by the Malay method of panning has survived to the present day. Since the first *dulang* passes were issued by the Government in 1907, the amount of ore recovered by this process in Perak has averaged 5 per cent of the annual output by all methods of production[5]. The Chinese, too, have adopted this Malay method, and in 1952, of the output of 8,174 piculs of tin-ore won by *dulang* washing in Kinta, more than 90 per cent was credited to the Chinese[6].

Panning or *dulang* washing is actually a method of recovery and concentration of ore rather than a method of extraction. It is used in the rivers and streams of Kinta, where the deposition of material eroded from stanniferous hill-sides has effected a natural concentration of ore. It is also used to recover tin from the abandoned tailings of mines. The pan, or *dulang* as it is called in Malaya, is a large shallow dish, usually made of wood, and very light. By a swirling movement of the *dulang*, the lighter particles of sand and gravel are carried away, leaving behind the black grains of tin-sand.

As far as other methods were concerned, the Malay miners were limited both by their lack of digging equipment and by the difficulty of preventing water from flooding the mines. They had, therefore, to concentrate their activities in shallow and easily accessible deposits near the foothills[7]. The depth of the mines was determined by the level of the water-table, and it was usual to cease working about a foot above that limit, though it was occasionally possible to mine ground to some five feet below this point[8].

The method most commonly used by Malays was sluicing, or *lampanning* as it was usually called. The ground around the mine was cleared and a ditch cut from the nearest stream. Water was led along this channel to the mine, and the earth containing *karang* was thrown into it. The mixture was stirred so as to break up the lumps of clay and liberate the ore from the other waste material. The larger stones were lifted out in a basket, and the rest of the mixture driven down-stream with a large wooden spade called a *pengayuh*. Small dams were placed in the ditch at intervals to retain the heavier tin-sand, which was then scooped out with a small wooden tray and deposited in a *palong*, or sluice-box, for partial concentration. The final concentration was effected in a smaller *palong* some five feet in

1. Tin-bearing ground.
2. Everitt, loc. cit.
3. Everitt, op. cit., p. 3.
4. Ibid.
5. Everitt, op. cit., p. 31.
6. *Annual Report of the Mines Department, Perak, 1952* (Ipoh, 1953). [Roneo].
7. Everitt, op. cit., p. 50.
8. J. E. de la Croix "Some Açcount of the Mining Districts of Lower Perak", *Journal of the Royal Asiatic Society, Straits Branch*, No. 7, (Singapore, 1881), p. 7.

length[1]. The limitation of depth imposed upon this form of mining by the level of the water-table meant that only the surface layers of *karang* were accessible to the miners. The ground was, therefore, only partially worked out and the landscape of the Kinta Valley became dotted with abandoned mines, usually filled with water. *Lampanning* also produced large quantities of tailings, which, together with the heavy erosion consequent upon the clearing of hill-sides, in later years caused the silting of the Kinta River and its tributaries, and brought about periodic floods.

(3) *Chinese Mining*

The Chinese were working tin-ore in Kinta as early as the beginning of the eighteenth century[2]. The technique of alluvial mining which they adopted in Malaya owed little or nothing to that practised in the districts of Yunnan and Kwangsi, where ore extraction was based on shafting and other underground methods; rather was it an adaptation of indigenous methods. Later the Chinese improved on these, and introduced their own digging tools, notably the *changkol*[3]. They also developed a method of draining excess water from the mine-pit by the use of the water-wheel and chain-pump. This enabled them to work profitably ground which the Malays had abandoned because of flooding.

The Chinese came from an environment where the emphasis had always been on labour and where machinery was used but little, and they brought with them their traditional methods of working. Their only significant contribution to the machinery of the Malayan tin-fields was the chain-pump, or *chin-chia*, as it was known locally. Apart from the introduction of this piece of machinery, the mainstay of a Chinese tin-mine was the labourer with his hoe and baskets on a balanced pole. The common Chinese mining method was open-cast, where with the introduction of the chain-pump to draw away excess water from the mine-pit, it was possible to mine to a greater depth than was reached by the Malays. There was, however, a practical limit beyond which this primitive pump could not operate This depended largely on the season and the position of the mine in relation to the water-table, and it was only after the introduction of the steam-pump in the late nineteenth century that the deepest layers of tin-bearing ground became accessible to miners.

When a site had been selected for mining, the jungle was cleared and the timber stacked ready to be used later for charcoal-making. The ground was then mined to a depth of six feet or until such time as water began to infiltrate into the workings, when a channel was cut from a neighbouring stream to the mine. Where this channel reached the mine-head, a water-wheel was erected to drive the chain-pump. Such a pump could dispose on the average of 1,500–3,000 gallons of water per hour[4]. The overburden was stacked around the mine-head so as to form a dam to divert the flow of surface waters during heavy rain. The *karang* was carried to the surface where concentration took place in wash-boxes. Waste material was deposited on the worked-out portion of the ground, while operations were continued both vertically and horizontally until the available land had been turned over and the *karang* exhausted.

In localities where there was a high percentage of clayey matter, it was necessary to puddle the *karang* before the tin-ore could be separated from the clay. This preliminary operation was usually done in large shallow boxes, at one end of which a stream of water was introduced. Around them stood a number of coolies with hoes, who stirred and thoroughly mixed the *karang* until the clay was separated from the tin-ore and gravel and floated away, leaving the ore behind. Another method of puddling was performed by means of a sort of human elevator, by which the *karang* was mixed with water and broken on its way

1. Everitt, op. cit., p. 50.
2. Hale, op. cit., p. 303.
3. A broad, deep hoe of various weights and sizes.
4. Everitt, op. cit., p. 55.

to the surface of the ground. On one side of the mine was cut a series of flat terraces, on each of which was stationed a coolie with a ladle. The coolie at the bottom of the mine lifted up the *karang* to his fellow on the step above, who in turn ladled it to the one above him, and so on until it reached the surface. The *karang* was mixed with water at each stage, and each handling assisted the disintegration process, until by the time it reached the wash-boxes at the surface, it had become thoroughly puddled and was ready for concentration.

The Chinese sluice-box or *palong* was an improvement on the hollowed tree trunk of the Malays. It consisted of a wooden trough with ruffles placed at intervals across the bottom for retention of the tin-sand. The *palong* was fixed at a slope of about one in twelve, with the wider end uppermost. One or more men were employed to mix the *karang* with a stream of water directed down from the upper end. The early *palongs* were about 30 ft. long, but later a shorter one of 12 or 14 ft. was used. A last washing was done in a *lanchute*, which was a coffin-shaped trough working on the same principle as the *palong*. The crude concentrate obtained from the *lanchute* was dried in the sun and later smelted.

In areas where the overburden was too deep or the *karang* too poor for open-cast mining, shafts were sunk, and the sides lined with thin planking, reinforced with timber. The usual shaft-mine consisted of two compartments separated by planks, with a man working in each compartment. In wet ground, the shaft was divided into three compartments, with the centre one at a lower level than the other two, thus serving as a sump for excess water, which was baled out in bamboo buckets and tins[1]. Crude windlasses were used for hauling up the tin-bearing *karang*. This method of mining was wasteful, as much of the *karang* was left behind after the richer layers had been exploited.

The simplest form of mining practised by the Chinese was an adaptation of the Malay method of ground-sluicing or *lampanning*. This method was suited for small-scale operations where the deposits were limited, the working faces small, and the area far from supply lines. In a lease of ten acres on a hill-side, there would probably be only a quarter of an acre of payable ground, so that the emphasis was always on economy[2].

In 1908 the Federated Malay States' Geologist and Senior Warden of Mines carried out a series of experiments on the efficiency of Chinese methods of treating *karang*. He concluded that, ". . . in cases where river action has already sorted out the alluvial ore into different grades and where therefore the Chinese miner has only to treat one grade of ore in his lanchute, the results are generally good. Where he has to deal with different grades mixed together, however, as sometimes occurs in cases where the ore has not been transported far, the loss, especially of fine ore, appears to be considerable"[3]. Earlier, however, a Senior Warden of Mines had formed a somewhat different opinion. "It is often alleged that a very large proportion of tin is lost in the primitive Chinese method of washing the tin gravel. A large proportion of this tin, however, is caught by the hundreds of women and children who are to be seen all over the mines washing up in the tail-races and on old heaps of tailings"[4]. It seems from these remarks that the *karang* often underwent two stages of treatment, the major process performed in the mines, and a minor recovery done by *dulang*-washers, working over abandoned tailings.

(4) *Modern Mining*

The introduction of European machinery dates from 1877 when the British Resident, Sir Hugh Low, had a steam engine and centrifugal pump installed in a Chinese mine in Taiping[5]. The replacement of the Chinese chain-pump by this more effective means of

1. Everitt, op. cit., p. 55.
2. C. E. Warnford-Lock, *Mining in Malaya for Gold and Tin* (London, 1907), p. 113.
3. *Annual Report of the Federated Malay States, 1908: Geologist's Report* (Kuala Lumpur, 1909), p. 3.
4. F. J. B. Dykes, "Annual Report of the Mines Department, F.M.S., 1903" in *Federated Malay States' Annual Report, 190* (Kuala Lumpur, 1904), p. 6.
5. L. Wray, "The Tin-mines and Mining Industries of Perak", *Perak Museum Notes*, No. 3 (Taiping, 1894), p. 15.

drainage immediately resulted in an extension of the depth to which mines could be operated. That such developments had not occurred earlier may be attributed to the difficulties of transporting bulky pieces of machinery to the region; but with the completion in 1895 of the Kinta Valley Railway linking the port of Telok Anson to Ipoh, and with the improvement of roads, there began the second phase of mining by mechanical techniques. The third phase was inaugurated in 1912 when the first dredge was introduced into Kinta, thus opening the extensive swamps in the south-western and central parts of the valley to systematic exploitation.

The machinery and methods introduced by European miners may be divided into three categories: those for surface excavation; those for lode mining; and those for mining in low-lying and swampy areas. The sequence of operations employed in surface mining usually consists of (1) breaking down the deposits containing the tin-ore, (2) lifting this broken ground to the surface, and (3) the separation of the ore from the waste material. In Malay and Chinese mines the deposits were broken down mainly by hand labour, but in the early nineteenth century European miners introduced two mechanical methods of doing this preliminary work. The first of these methods was hydraulic mining, or hydraulicking, introduced into Kinta by the *Gopeng Mining Company* in 1892. This depends on the natural pressure obtained by damming a stream some hundreds of feet above the mine, and conveying water through pipes to the working face of the mine. The pressure produced depends upon the height of the source of water above the mine and the size of the pipes used. A monitor is attached to the end of the pipe and the jet of water that issues out of it is usually of sufficient force to break down even the toughest deposits. It has been calculated that a three-inch jet under a pressure of 170 pounds per square inch has a potential energy at the mouth of the nozzle of 340 h.p.[1] Not only was hydraulicking a technical improvement upon *lampanning*, but, whereas the Malay method was limited in its operation to shallow alluvial deposits, hydraulic mining could work the entire hill-face and extract ore that had formerly been inaccessible[2]. In addition, the use of pipes for the conveyance of water to the mine-face allowed the miner greater freedom in the choice of site, which in *lampanning* was restricted to the locality of a stream.

The second important European introduction was the mounting of a gravel-pump on a floating pontoon. By this method tin-bearing ground is broken down by water issuing from a monitor nozzle under artificial pressure. It is used where cheap power can be obtained and where the water can be used again for raising the *karang* by means of gravel-pumps. The usual method is to mount two large pumps (either steam- or oil-operated) on a pontoon. One pump then works the monitor which directs a jet of water against the mine-face and breaks down the ground, and the other raises the debris to the concentration plant. This is a process particularly adapted to mining in limestone areas, where the existence of numerous pinnacles and troughs renders bucket-dredging difficult or impossible, and where the surface of the limestone is so irregular that a high percentage of tin is trapped in each hollow. Only water under pressure is able to flush out these hidden deposits, which would otherwise be lost. It is estimated that the quantity of ore recovered by this method in limestone areas may be as much as 50 per cent above that recovered by a bucket-dredge of the older type[3]. Just prior to the Japanese occupation a vertical type of gravel-pump was introduced into the tin-fields of Kinta. It was suspended from a tripod and could be raised or lowered at will for the purpose of cleaning out pockets of tin-ore lying between limestone pinnacles.

Before the introduction of mechanical methods, broken *karang* was raised to the surface of the ground by hand labour. In Chinese mines it was lifted in baskets balanced

1. Jones, op. cit., p. 80.
2. Warnford-Lock, op. cit, p. 130.
3. Hutton, op. cit., p. 177.

on a pole, or carried up inclined ramps in wheelbarrows, or was ladled up from terrace to terrace. Later small trams running on light rails were used to haul the *karang* up to the surface. But today the two most common means of raising broken ground are (1) the gravel-pump and (2) the hydraulic elevator. The gravel-pump was introduced by Messrs. Osborne and Chappel at Tanjong Rambutan in 1906. It can be driven by steam, oil or electricity, and is used to raise the mixture of water and tin-bearing ground broken up by the monitors to the surface for concentration. The diameter of the pump varies from six to sixteen inches; in Chinese mines the usual size is eight to ten inches. The maximum elevation of such pumps is 80 ft. but they are most efficient at heights below 60 ft.[1] In deep mines a double lift may be needed, with a second pump raising the mixture above the point reached by the lower one. The gravel-pump is used also for disposing of tailings from the *palongs*, thus performing two functions at the same time.

The hydraulic elevator works on the suction principle. A jet of water, under a natural pressure of from 60 to over 200 pounds, is projected up the inside of a pipe. The suction caused by the passage of the water in the pipe draws up sand and slime from the bottom of the sump and raises the mixture to the top. The success of this method of mining depends on the availability of a source of water of sufficient height to provide the necessary pressure. Such elevators have been used with great success at the *Gopeng Consolidated Mines*, the *Kinta Tin Mines* and the *Tekka Mines*[2]. But it should be noted that hydraulic mining with elevators produces a considerable quantity of tailings, the disposal of which constitutes a major problem to the companies concerned.

The process of separation of the tin-ore from the waste material remains essentially the same as in the old Chinese mines and consists of a sloping *palong* mounted on a wooden scaffolding. With the introduction of bucket-dredging, jigs took the place of *palongs*, though the latter continued to be used with gravel-pumps and other methods of mining. Water is essential for all such separation processes.

Lode-mining, with modern machinery for ventilation of the shafts and for haulage, is not dissimilar to that practised in Cornwall. Previous to the introduction of modern techniques, pipes and veins of ore exposed by *lampanning* on the hill-sides could not be exploited because of bad ventilation and excessive seepage of water. The first attempt to provide adequate ventilation was made in 1888 when a steam-driven fan was installed at the Lahat mine to force air into underground workings[3]. Owing to the limited extent of the veins, only rich ores can be extracted economically. Continouus shaft-sinking is necessary to follow the vein or pipe downwards, and the nature of the deposit makes the daily output small. In the famous Lahat Mine, the pipe was followed to a depth of 314 ft., and by 1908 bores had been sunk to 600 ft. without encountering any granitic rock[4]. Although in Kinta in 1952 lode-mining accounted for only 0.82 piculs of ore (out of a total production of 590,362 piculs)[5], it may become of great importance in future years as detrital deposits are exhausted, and the miners turn their attention to the primary source of ore in the hills.

A major advance in the progress of mining was made in 1912 when the first dredge was set up in Kinta. An attempt had already been made in the latter half of the nineteenth century to dredge the Kinta River for tin, but the project had to be abandoned because of fallen timber buried in the channel[6]; while in 1906 Messrs. Osborne and Chappel had introduced a dredge at Tanjong Rambutan. This dredge was actually a gravel-pump mounted on a pontoon, and was more a forerunner of the modern gravel-pump than a bucket-dredge as it is known today[7]. At one time, too, at least one suction-cutter dredge

1. Jones, op. cit., p. 82.
2. Jones, op. cit., p. 83.
3. Everitt, op. cit., p. 68.
4. *Federated Malay States' Geologist's Annual Report, 1908*. p. 3.
5. *Annual Report of Mines Department, Perak, 1952.*
6. *The Straits Times* (Singapore), 8th Aug., 1891.
7. Everitt, op. cit., p. 92.

was at work near Batu Gajah. In this type of dredge the ground was broken by a set of revolving blades at the lower end of a ladder that could be raised or lowered, and the broken ground was drawn up a suction pipe by a large gravel-pump. This method proved unsatisfactory, however, if stiff clays or sunken timber were encountered, and also because the heavy particles of cassiterite tended to settle to the bottom in the churning process, so as to reduce the recovery.

In 1912 *Tronoh Mines* bought a dredge to work their tailings, but the attempt was not successful. In the same year, the *Malayan Tin Dredging Co., Ltd.* constructed a dredge to work its property at Batu Gajah, and this was the first successful attempt at bucket-dredging in Malaya[1]. During the first year of operations 3,780 piculs of ore were recovered from 579,000 cubic yards of ground. The dredge had a steel hull 150 ft. long by 35 ft. wide, with a mean depth of 7 ft. 6 in., and a digging capacity of 80,000 cubic yards per month[2].

Dredging solves the difficulty of working deposits in swampy or very wet ground, which previously could not be attempted without the use of expensive pumping machinery. It has the decided advantage of being able to treat low-grade ground at a lower cost per cubic yard than is possible by any other method, as well as of being able to work in wet localities. It has been estimated that areas as low in tin content as ¼ lb. tin ore per cubic yard may eventually be dredged with profit[3]. As a result of this new technique, extensive areas of land formerly considered too poor in tin to be worth working, or which had already been exploited by other methods but still contained sufficient ore for profitable dredging enterprise, were opened to the miner. Dredging has several further advantages over other methods of mining. It is, for instance, free from one of the serious drawbacks attending hydraulic mining, viz., the creation and subsequent disposal of large quantities of tailings. Moreover, unlike hydraulic mining, dredging does not seriously damage the surface of the ground. It leaves no permanent holes such as result from other forms of mining. The ground is, in effect, merely turned over, and the tin-ore extracted from it. Thus, provided that the top-soil is stripped off initially and replaced after the ground has been worked over, the general effect of this form of mining is not serious or permanent. In point of fact, dredging in swampy flats may actually increase their agricultural potentialities by improving the drainage. The dredged-over ground occupies a much greater cubic space than the original compact earth, so that its level is raised, whilst its disintegrated, loose state facilitates the filtration of excess water through the subsoil[4]. Dredging also lends itself to the systematic and thorough exploitation of large areas of mining land, with little or no loss of tin.

There are, however, certain conditions necessary for successful dredging operations. The large capacities of the dredges render it necessary for the companies to acquire extensive areas of land to keep their equipment at work regularly, but there are limits to the amount of land available for dredging in Kinta. The area, in fact, varies from year to year according to the acreage of new mining land acquired and the number of old mining titles cancelled. A partial solution to this problem is to build dredges that can dig deeper, and in 1940 there were dredges in Kinta that could excavate to 130 ft. below water level, that is, to almost three times the depth of the first dredge introduced in 1912. Such machinery, however, represents a very high capital cost compared with that required for the simpler equipment of a gravel-pump mine.

Although production from dredges in 1952 was approximately half the total output of Kinta (304,620 piculs out of a total of 590,362)[5], conditions in the middle and upper

1. O. B. Williams "Brief History of Malayan Dredging", *Journal of the Mining Association of Malaya*, Vol. 4, No. 4 (Dec., 1936), p. 292.
2. Everitt, op. cit., p. 94.
3. C. L. Mantell, *Tin* (New York, 1949), p. 98.
4. C. C. Longridge, "Gold and Tin Dredging" *The Mining Journal Publication*, Third Edition (London, N.D.), pp. 181–2.
5. *Annual Report of the Mines Department, Perak, 1952.*

sections of the Valley are not as favourable to dredging as they are in, say, the Larut fields. In Kinta the tin-ore is distributed throughout the mass of the deposits, but the nature of the limestone bedrock is such that the ordinary bucket-dredge cannot thoroughly clean its upper surface[1]. Production then depends largely on whether the tin values lie close to the bedrock or are above it, the latter condition being more favourable to a thorough recovery of ore[2].

European mining methods lay emphasis, generally speaking, upon mechanical operations and upon the ability to mine large areas of ground quickly and efficiently. These methods are, therefore, almost exclusively dredging and hydraulic mining. A prerequisite for successful European undertakings is the acquisition of large areas of mining land so that the machinery can be kept at work continuously for long periods, while hydraulic mines also require locations near sources of cheap water-power. Areas which do not fulfil these conditions are worked by Chinese miners, who place their trust in cheap labour rather than in machinery. Production by European mines in 1952 amounted to 59·5 per cent of total production in Kinta, while Chinese-operated mines, excluding *dulang*-washers, produced 39·24 per cent[3].

The Pattern of Mining Land Use

Tin-mining methods in Kinta have shown continuous adaptation and evolution to suit local conditions, and miners have not been slow to incorporate processes foreign to Malaya, such as dredging and hydraulicking. Tin is at present won by five main methods, the relative importance of which is indicated in the following table.

Table 3: Production of Tin Ore in Kinta, 1952, according to Methods of Mining[4]

	Piculs
Dredging	304,620
Gravel-pumping	257,309
Open-cast	—
Hydraulicking	27,577
Underground	0.82
Miscellaneous	835
	590,362.82

In addition there were 3,011 *dulang* passes issued, which yielded 8,174 piculs of tin ore.

It is possible to distinguish a significant pattern in the distribution of these various types of mining activity. Fig. 4, depicting the location of all mines in Kinta in 1953, shows that most of the dredges occupy the valley flats, especially the area south of Batu Gajah, while other types of mining, mostly gravel-pump and hydraulic, are distributed on either side of the Kinta River, along the foothill zone. In recent years the trend of mining has been towards the central part of the valley. The earliest mines were located along the foothills and slopes of the granite ranges that flank the valley, in areas that were accessible by water and at the same time had the necessary natural conditions of free drainage. The choice of sites by Malay miners was still further restricted to areas that were close to streams, where *lampanning* could be carried on. It was a coincidence that the flanks of the ranges on which these early mines were located were also the areas with the richest concentrations of ore.

1. In the lower part of the valley, however, in the vicinity of Tanjong Tualang, conditions are much more favourable for large-capacity, deep-digging dredges. Here the alluvium tends to be deeper, and the better tin values are often found at some distance above the bedrock, where their recovery is less handicapped by pinnacles.
2. A. C. Perkins, "Tin Dredging in the Federated Malay States", *F. M. S. Chamber of Mines Year-Book* (Kuala Lumpur, 1916), p. 3.
3. *Annual Report of the Mines Department, Perak, 1952*, Table, 9.
4. *Annual Report of the Mines Department, Perak, 1952*, Table 8.

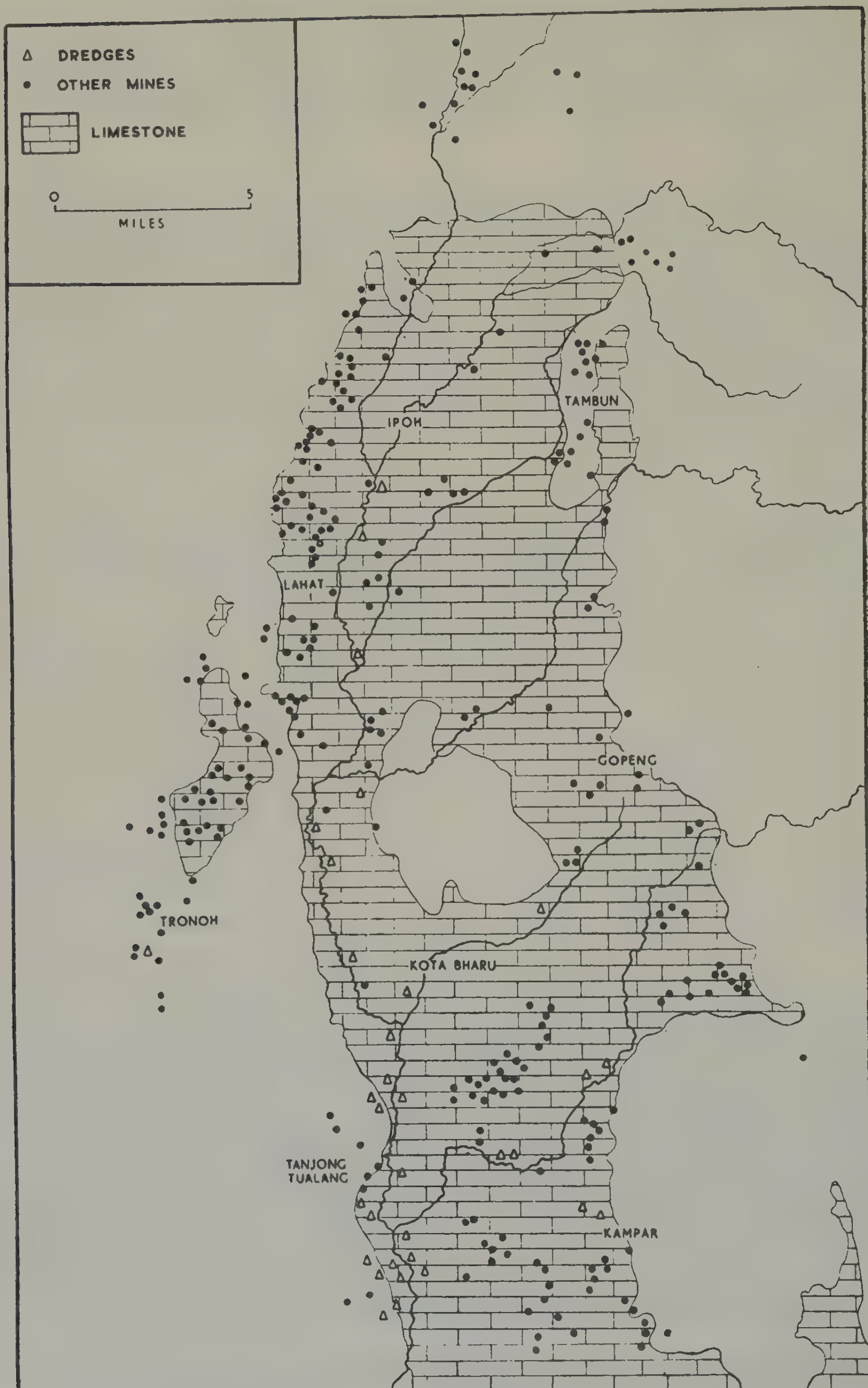

Fig. 4. Distribution of mines in the Kinta District, July 1953. Compiled from information supplied by the Department of Mines of the Federation of Malaya. Notice of recent revisions of the limestone boundary by the Geological Survey of the Federation of Malaya reached the editor too late to be incorporated in this map. Briefly, their inclusion would have brought a greater proportion of mines in the Tronoh, Tanjong Tualang and Tambun districts within the limestone belt.

The Chinese miners worked in roughly the same locations as the Malays, but the introduction of better mining techniques, especially of improved methods of draining off excess water in the pits, allowed them greater freedom in the choice of sites. Thus, areas further away from the foothills, and lands until then inaccessible because of the proximity of the water table to the surface of the ground, were opened to practical exploitation.

Today high standards of technical skill permit the mining of deep deposits, and also of those containing only a small percentage of ore. As the richer granite-contact zone deposits are being exhausted the miners are concentrating their efforts on dredging the extensive swamp-lands and river flats in the central portions of the valley. It is probable that, as the lowland detrital deposits are exhausted, this movement inwards from the sides of the valley may be followed in future years by an outward movement once again, this time towards the hilly regions of the Kledang Range and the Main Range, where large-scale lode-mining for the primary ore of the granite intrusions can be undertaken.

CHAPTER II

WATER AND CLIMATE

TIN MINING in the Kinta Valley today is concerned almost exclusively with alluvial ores and is, therefore, based on methods which depend directly or indirectly on water. In fact, the Malays distinguish two main groups of mines on the basis of this use of water: (1) those in which water is brought to the tin-bearing ground and used to concentrate the ore on the spot: these are called *lampans*; (2) those in which the ore is excavated by *dry* methods and taken to the water to be concentrated: these are called *lombongs*. With one or two exceptions, modern mines are either *lampans* or *lombongs*, and are similar in principle to primitive Malay mines; but they differ greatly in efficiency and speed of ore-extraction.

The most important role of water is as a separating agent. Tin-ore occurs as a heavy and usually dark-coloured sand[1], and the cheapest and most efficient method of separating this ore from lighter waste materials is by sluicing with water, which carries off the lighter particles and leaves the heavy tin sand as a concentrate. Although the forms and methods used for this separation process have varied with the progress of mining technology, the principle behind all of them has remained the same, with water as an essential agent in all cases.

Water is also important in other processes. In 1952, about half of the Kinta tin output was obtained by gravel-pumping and hydraulicking[2], two forms of mining which depend on monitors for breaking down stanniferous deposits prior to concentration in *palongs*. Monitors direct a jet of water at the working face of the mine with sufficient force to disintegrate even the hardest deposits. Water thus assumes the role of an excavating agent. Moreover, apart from these two functions of excavation and separation, in gravel-pumping water also acts as a carrier for solids, raising the broken-down deposits in pipes to the surface of the mine, and later distributing the tailings from the *palong* to the retention area.

THE PROBLEM OF EXCESS WATER

In the early days of mining water performed only one function, that of separation. The three main methods of mining were *dulang* washing, *lampanning* in the hill-sides, and open-cast mining by the Chinese, and in all of them sluicing of the stanniferous deposits was performed directly on the mine site. But although water was essential for all forms of mining, excess water provided a major problem that was not solved until the introduction of the steam-pump in the late nineteenth century. Under the heavy rainfall of Kinta, water is never far from the surface of the ground, and mining depths were limited both by seepage into the pits, and by the direct inflow of rainwater from the surface of the ground. Apart from baling, the early miners had no means of getting rid of this excess water and they were, therefore, restricted in the scope and depth of their operations. Hill-sides were the best sites for mining for two reasons. Natural run-off and good drainage minimized percolation, and the water-table was usually farther from the surface of the ground than in the valleys. Chinese miners were somewhat less restricted by these environmental factors for they had introduced several crude methods of baling out excess water.

1. Specific gavity 7·5.
2. *Annual Report of the Mines Department, Perak, 1952*, Table 2.

The *lombong siam* of the early miners were sunk on hill slopes to allow for natural drainage. The pits were seldom more than 30 ft. deep, but whether this limit was imposed by water flooding the mines or by fear of the sides collapsing (in the total absence of timber supports) is a question that has not yet been answered[1]. The natural consequence of this limitation was that mining was shallow but extensive, and the foothill landscape became pocked with abandoned mining pits, usually filled with water.

Malay miners normally adopted the method of ground-sluicing. The success of this method depended upon a critical incidence of rainfall: too little resulted in a shortage of water for sluicing, and too much caused flooding of the mine and its subsequent abandonment. The ditches in the *lampans* were rarely more than ten or fifteen feet deep, depending upon the location of the mine and the height of the water-table. It was sometimes possible to mine to a depth of about five feet below ground-water level, but it was rare for a Malay mine to be deeper than this[2]. Apart from natural drainage, the only means of keeping the mines dry were the *penimba* (a type of baling bucket made of bark) and a balanced pole with a bucket on each end, which was used only in the larger mines[3]. The Malays were thus limited both in their choice of mining sites and in the depth to which they could penetrate. Hence most of their activities were confined to the Kinta River and its tributaries where *dulang* washing was used to recover stream tin, and to the sides of the Kledang and the Main Ranges[4], particularly those areas bordering the main rivers or accessible by jungle paths. In 1885 there were 104 of these old Malay mines covering an area of 577 acres in Kinta, together with a further 133 unsurveyed mines estimated to cover another 600 acres[5] (Fig. 6). None of these old *lampans* is producing today and many, if not most, of the sites are now being re-worked by more efficient methods.

Mining was only partly freed from climatic control by the introduction of the Chinese *chin-chia*[6], but this ingenious means of draining off excess water did render the deeper but richer *karang* beds accessible; and this, together with the use of more methodical and efficient Chinese mining techniques, constituted a major advance in the mining history of Kinta. It also helped to eliminate the wasteful method of ground-sluicing, which dotted the landscape with a large number of abandoned, but not wholly exhausted, workings.

The *chin-chia* was a direct borrowing from the rice-fields of China[7]. In Kinta the Chinese found an abundance of forested land that enabled them to put to maximum use their ability to construct implements from wood. The *chin-chia* is an example (Fig. 5). It consisted of an endless wooden chain driven round two wooden wheels of unequal diameter, the upper one being larger than the lower. The chain consisted of small wooden slats, spaced at regular intervals, and fitting into a trough made of hundred-foot planks so as to render each compartment fairly water-tight. The whole contraption was placed in a slanting position across the mine, so that one end of it rested on the edge of the pit and the other dipped into the pool of water to be drained out. The larger wheel at the upper end was in effect a water-wheel, and was driven by a stream of water drawn from any convenient source near-by. Fitted to the axle of this wheel were cogs, each of which drew up a joint of the endless chain. In succession, each compartment thus raised a quantity of water from the floor of the mine to ground level. This water was then discharged into a channel, which at the same time led off the stream providing the motive power for the wheel. This channel of water, or tail-race as it was called, was also used at times to drive another pump in a mine at a lower level, and also to treat the *karang* in the *palong*.

1. Everitt, op. cit., p. 2.
2. Everitt, op. cit., p. 50.
3. Everitt, op. cit., p. 57.
4. Hale, op. cit., p. 303.
5. *Raffles Museum Archives*: *Dispatches from the Secretary of State, 1886. Enclosure No. I* in *Annual Report of the State of Perak*, p. 28.
6. See p. 8 above.
7. *Blue Book of the Larut District in the Native State of Perak for the Year 1874* (Singapore, 1874), paragraphs 59–60.

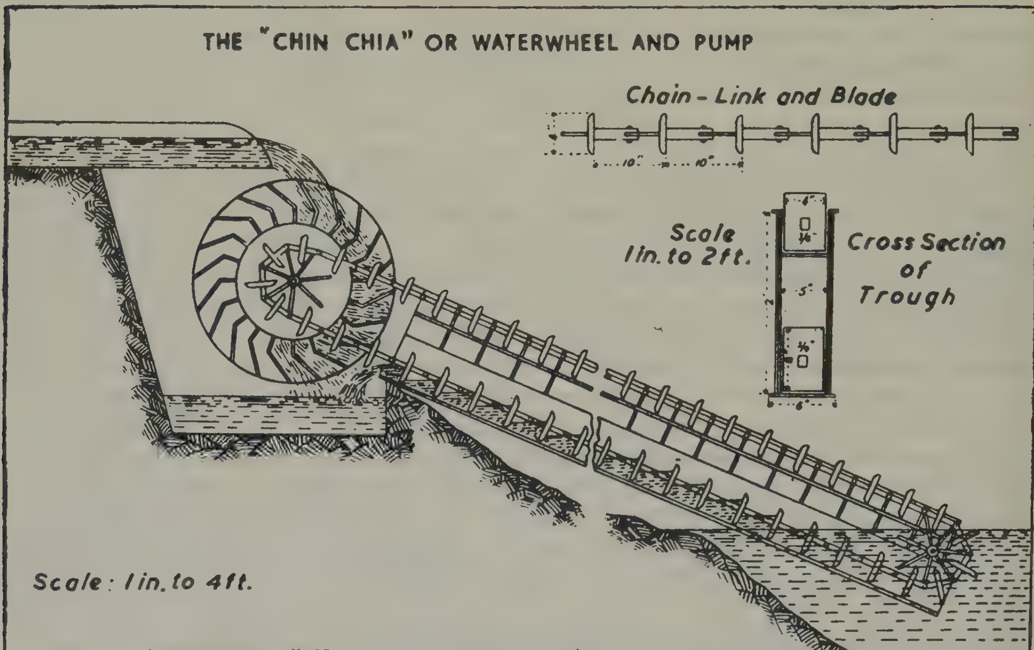

Fig. 5. Diagrammatic section to show the working of a *chin-chia* or chain pump (see text, p. 17). Re-drawn from P. Doyle, *Tin Mining in Larut* (London, 1879), p. iii.

Although the *chin-chia* could pump out an average of 1,500–3,000 gallons of water per hour its successful operation still depended on the constancy of the stream providing the motive power. When this failed, as it often did in a dry spell, work had to cease. On the other hand, during the wet season water percolated too quickly for the pumps to deal with it effectively, and work again came to a standstill. Such was the dependence of Kinta mining on rainfall that, on the average, mines could be worked for not more than six months in the year.

The steam-pump was introduced into the tin mines of Perak as a Government experiment. It proved successful and was rapidly and widely adopted in the larger Chinese mines. These pumps were of the centrifugal type, and their main function was limited to draining excess water from mines. Later they assumed an additional function, that of a carrier for solids, and the gravel-pumps of today perform these two functions simultaneously. Mining methods otherwise remained much the same, but tin production increased, largely because the new pumps afforded miners greater freedom from rainfall control. They also liberated miners from a too restricted choice of sites, for good natural drainage was now of much less importance and no stream was required to drive the water-wheel.

Swamp Mining

Although the introduction of mechanical pumps opened up large tracts of land, there still remained tin-bearing areas inaccessible to miners. In particular there were the extensive swamp-lands which stretched from a little north of Batu Gajah to the mouth of the Perak River (Fig. 1B). Standing water in these swamps presented special problems, and there were no large-scale attempts to extract their tin until dredging was introduced early in the present century. The importance of these swampy areas as a source of stanniferous wealth

can be gauged from the recent production of tin-ore. In Kinta in 1952 there were thirty-three dredges at work, producing 590,362 piculs of tin-ore, that is approximately 50 per cent of the total obtained by all methods. Most of these dredges were employed in the area between Batu Gajah and Tanjong Tualang (Fig. 4).

Although bucket-dredging has been found to be the cheapest and most efficient method of working extensive water-logged, stanniferous areas, the first dredge introduced into Kinta was not designed specifically as an answer to this problem, but was used in 1912 in an unsuccessful attempt to dredge the tailings of the Tronoh mines at Tanjong Rabmutan [1]. In the same year the *Malayan Tin Dredging Company* used a dredge to work its property at Batu Gajah, and this proved to be the first successful attempt at dredging in the whole of Malaya [2]. The first dredges used were not bucket-dredges at all but were forerunners of the modern gravel-pump [3]. The essential feature was one or more centrifugal pumps mounted on a pontoon which could be floated to any part of the mine. The method was not "dredging" as it has come to be understood, but rather a mobile form of open-cast working.

The bucket-dredge introduced by the *Malayan Tin Dredging Company* at Batu Gajah differed from the older gravel-pump pontoons. Everitt describes it as follows: "A bucket dredge with steel hull 150 ft. long by 35 ft. wide, with a mean depth of 7 ft. 6 in. was floated in 1912 . . . The open connected buckets were each of 10 cubic feet capacity, and were arranged to travel at a variable speed of 10–12 per minute along the bucket ladder, which was long enough to permit digging up to 50 ft. below water level. The estimated capacity was 80,000 cubic yards per month. Two Sisson high speed compound condensing engines were used to drive the buckets and the pumps. The ground excavated by the buckets was delivered at the top of the bucket ladder into a revolving screen where jets of water were used to break up the clay. From the screen the resulting sludge was treated in sluice boxes 90 ft. long and totalling 32 ft. wide. Water for washing the ore was supplied by one 16 inch, one 12 inch and one 6 inch high pressure centrifugal pump capable of delivering 9,500 cubic feet of water per minute. A belt conveyor extending 116 ft. beyond the stern of the dredge disposed of the tailings and overburden" [4].

This bucket-dredge was introduced from New Zealand where it had been used to scoop gold from the rivers. The problem set by standing water in areas containing reserves of tin was overcome not by pumping out the water from the area, which would have been a difficult and expensive task, but by launching the mining equipment on a pontoon and digging down from the floating platform to the tin-bearing strata below water-level.

The Effect of the Weather on Mining

As a result of these technological advances excess water no longer prohibits mining, but the availability of water for sluicing still remains an essential factor in all mining operations. The material consequences of this technical progress are manifest in the increased production resulting from greater digging depth and the low incidence of stoppages due to flooding of mines. A deficiency of water, however, can be as serious a problem as an excess. In 1928, for instance, an abnormally dry period resulted in a severe shortage of water during the first four months of the year. In May a rainy spell eased the situation temporarily, but the very hot and dry period which followed and lasted until the end of October made the water shortage so acute that " . . . water was conserved and circulated [in the mines] until in some cases it became so charged with slime as to turn almost to the consistency of mud" [5]. Many mines had to close down because of this shortage.

1. Williams, op. cit., p. 292.
2. Ibid.
3. Everitt, op. cit., p. 92.
4. Everitt, op. cit., p. 94.
5. "Annual Report of the Kinta District, 1928", in *Perak Annual Report, 1928* (Batu Gajah, 1929), p. 4. [Roneo].

The main effects of the weather on mining are summarized below.

(1) A period of drought leads to a shortage of water which is essential for operations in hydraulic and gravel-pump mines. Prolonged drought may lead to curtailment of mining activities in areas far from perennial sources of water.

(2) A period of excessive rainfall leads to a temporary flooding of many mines, and may also cause land-slips in the excavations. Moreover, it may also result in the bursting of dams and of bunds in the tailings retention areas, and thus entail extensive damage as waters escape into the surrounding countryside.

(3) A period of unevenly distributed rainfall may lead to a combination of both effects, and generally results in the curtailment of operations and loss of efficiency.

It is, therefore, apparent that the incidence of rainfall is of more importance to tin mining than the volume, for the total precipitation in Kinta remains more or less constant. An even distribution of rainfall throughout the year is that most favourable to mining activities.

Thus water plays a varied role in present-day mining in Kinta. Apart from acting as an excavator for hydraulic and gravel-pump mining, and as a carrier of solids and distributor of tailings in gravel-pump mines, it is also a separating agent. The abundance of both surface and ground water[1], and its fairly even distribution over the valley, is one of the major factors contributing to the relative cheapness with which tin is produced in this region as compared with other parts of the world. Moreover, in recent years water has become very important as a source of power and, particularly in dredging, is used to generate electric energy to drive mining machinery. The Perak River hydro-electric station, for example, supplies power to many of the dredges operating in Kinta.

1. The mean annual rainfall in the Kinta Valley exceeds 90 in., e.g. Batu Gajah 99·69 in. (49 years)—From records of the mean monthly rainfall at various stations in Malaya. *Malayan Meteorological Service.*

CHAPTER III

ACCESSIBILITY AND TRANSPORT

WATER TRANSPORT

IN THE early days of mining the inaccessibility of the stanniferous deposits of the Kinta Valley was a major difficulty. Between the valley and the coast was a zone of impenetrable freshwater swamp-forest, which formed a natural barrier to miners seeking a way to the tin-fields, while overland penetration was impeded by the Kledang Range, through which there was no easy way from Larut to Kinta. The only possible entrance to the rich alluvial deposits of the valley was along the Kinta River and its tributaries. These, together with the Perak River, formed a natural highway into the interior, and enabled the first miners to gain access to the foothills of the Main Range where the richest tin deposits were found.

The Malay peasant economy of that time was based on subsistence agriculture, with rice as the staple food crop and fish as an important supplement. The indigenous population was spread along the coast or along the banks of the main rivers, wherever potable water was available and fishing could be undertaken. In this amphibious environment the boat was a very important means of communication, and distances were usually calculated in terms of rowing and sailing hours. The resulting transport pattern, in which the rivers and sea constituted the highways, reflected this dependence upon the *sampan*[1] and *prahu*[2]. Land communication was negligible for two main reasons. First, almost continuous swamps inhibited movement on land, and second, as the Malay economy was centred on the coastal fringe, there was no incentive to penetrate overland into the glommy and repellent interior. Such communication was thus confined to movement along footpaths leading from one *kampong* to another, and insignificant excursions into the fringes of settlement to collect jungle produce. Apart from these footpaths, there were also tracks made by aborigines and elephants among the interior mountain ranges.

Penetration into the Kinta Valley was along the Perak River as far north as Kuala Kinta, and then by way of the Kinta River into the Valley proper. The first mines were thus concentrated along the banks of the Kinta and its tributaries, the rivers serving not only as a means of ingress for stores and machinery but also as a means of export for the ore produced. Ore was washed in the beds of the streams as well as extracted from the land along the banks at the foot of the hills. A population of three or four hundred persons was employed in mining for ore at Bidor, which was five to six *sampan* days up-stream from the confluence of the Kinta and Bidor rivers. It was estimated that there were altogether about 2,000 miners working the valley sides in Kinta at that period[3].

By the eighteen-eighties the situation had not changed greatly, except that more areas were open to exploitation and miners had penetrated as far north as Ulu Kinta. The main centres were then at Sungei Trap, Sungei Kampar, Sungei Chenderiang, and Ulu Kinta, this last being the least worked as it was furthest from the sea. The greatest concentrations of mines were at Sungei Pari and Sungei Chemor, where the tin deposits were especially rich. Near Ipoh the bed of the Kinta River was washed for tin by Malays employing the *dulang* method. On the Sungei Trap some 500 Chinese and Malays worked thirteen mines, concentrated on the rich pockets of the Sungei Papan valley. The Sungei Raia, another tributary of the Kinta, was also a rich tin area and there were between six and seven hundred

1. The word used throughout the Far East for a kind of harbour-boat or dinghy.
2. The Malay word for any sailing or rowing vessel.
3. Wray, op. cit., p. 14.

Chinese miners, as well as many Malays, in the valley. The Ulu Gopeng valley had been worked for many years and the easily accessible deposits exhausted, so that during this period there were only four *kongsis*[1] with 150 men engaged there, whereas earlier there had been 15 *kongsis* with 7–800 men. Malays with their headquarters at Kampong Senudong, had been *lampanning* in the Sungei Kampar valley for some time, but the Chinese did not start to mine there until the 'eighties. The tin from these mines in Upper Kinta was transported by elephants overland from Gopeng to Pengkalen Bharu on the Sungei Raia, where it was shipped to Durian Sabatang[2].

As these operations gathered momentum, the miners began to go further afield in their search for tin reserves and pushed their way into the interior lands, away from the immediate vicinity of the rivers. Gradually a new transport pattern evolved. This new network still hinged on the waterways, but was supplemented by tracks and footpaths joining mines in the interior to ports on the Kinta River (Fig. 6A). There were no roads as such, and much of the tin was carried by elephants to Kota Bharu, the only village of any size before 1874[3]. This *kampong*, situated at the confluence of the Teja and the main river, was an important calling-place for boats bringing goods from Telok Anson to the Kinta area. As a return freight they carried the ore mined in that region.

The main port of Kinta was Telok Anson, situated some eighteen miles up the Perak River. The original port was Durian Sabatang, but it had been removed to a deeper anchorage called Telok Mah Intan, which was renamed Telok Anson[4]. The anchorage was sufficiently deep to accommodate vessels drawing up to 16 ft. of water, The port was an entrepôt not only for tin exported from Kinta, but also for labour, goods, and machinery entering the mining district. With the development in 1896 of the Kinta Valley Railway Line connecting Telok Anson with Ipoh[5], the port became the centre not only of sea and river transport, but also of rail communication. In later years, however, with the gradual silting up of the Kinta River and the opening of through communications between Penang and the Kinta District, Telok Anson gradually declined in importance. As a waterway, the Kinta River suffered from several serious disadvantages. Its channel was in may parts tortuous and narrow, with fallen timber forming dangerous obstructions to shipping. The river was often rendered impassable during periods of flood, and although small river launches could normally reach Batu Gajah, the shallow upper reaches were unnavigable during a drought. The native sampans were often incapable of carrying the heavier types of goods, which, before the advent of powered boats, had to be transported overland by elephants, or by coolies—a long and difficult process[6].

But despite these disadvantages, in the early periods of development the river provided the only practicable means of access into the valley. A large amount of state revenue was spent each year in keeping the channel clear of obstructions and in widening them when necessary, but the subsequent intensification of mining activities and the lack of adequate control over the disposal of waste material from the mines, gradually choked the river and its tributaries with mining effluent. The main channel ultimately became so shallow that the Sungei Kinta ceased to be of any material use as a means of communication.

Another factor operating to bring about this decline in the importance of the Kinta River was the construction of railways and roads, which provided faster and cheaper transport direct to Penang. In December, 1896, the Resident of Perak, Mr. W. H. Treacher, wrote in connection with the Kinta Valley Railway Line: "The competition of the Kinta

1. A group of miners working together as a company.
2. Everitt, op. cit., pp. 61–2.
3. *Raffles Museum Archives*: *Perak Council Minutes*, 20th February, 1880, p. 2.
4. Everitt, op. cit., p. 20.
5. See p. 25 below.
6. *Penang Gazette*, 1 May, 1888. Even as late as 1888, when Gopeng was destroyed by fire, boats carrying relief took four days to reach it from Telok Anson, only fifty miles away.

River is still being felt, but should decrease as the higher part of the river becomes silted up by the operations of the miners. By special arrangement, the railway has secured the entire carriage of tin and tin-ore"[1]. Deprived of the carriage of this commodity, which hitherto had been the *raison d'être* of its existence as a highway, the Kinta River soon ceased to function as a means of transport and communication.

The Early Road System

In the early days of mining movement on land was by way of tracks and footpaths connecting mining or administrative centres with the Kinta River and its tributaries. These tracks were used mainly by elephants, which were the usual transport animals, and subsequently, with the arrival of Chinese coolies in large numbers, by human porters. Later these tracks gave place to bridle paths, and still further improvements came with the construction of roads designed for slow-moving bullock carts[2]. Each area had its own peculiar set of difficulties, and consequently these tracks, paths, and cart-roads varied a great deal from place to place. The commonest type was a roadway in the form of a bridle path, six feet wide and unmetalled. Rivers and streams were crossed by very simple and cheap bridges constructed with timber from the surrounding forests.

The roads from the mines in the interior of the Kinta Valley generally ended on the bank of the main river. At this junction, where land portage gave way to water transport, there usually grew up a *kampong*[3]. In other instances roads were built from mining areas to the nearest existing riverine *kampong*, which then acted as a distributing centre for food and other necessities, and as a collecting point for the tin produced in the region. This latter was then sent by launch to Telok Anson and on to Penang. Before 1874 the largest *kampong* was Kota Bharu, at the confluence of the Sungei Teja and the Kinta. This *kampong* was the collecting centre for the tin produced in the whole of the Gopeng area. The route leading to these mines was an old and difficult one. It led from Kota Bharu up the Sungei Raia, and thence by a devious path to Gopeng (Fig. 6A). The first road built in Kinta was driven direct from Kota Bharu to the Gopeng area to supplant an indirect route via the Sungei Raia.

Another important mining locality was the Lahat-Papan area on the right bank of the Kinta River. There was no *kampong* suitable for a depot near this group of mines and so a new one was created—the port of Batu Gajah at the confluence of the Raia and the Kinta Rivers. During the eighteen-eighties the Kinta was navigable by small launches from Telok Anson as far as Batu Gajah (Fig. 6A). Later, this new port became the first headquarters of the Kinta District[4]. This process whereby road and river met at a junction village continued until 1891, by which time every important mining areas was linked with the Kinta River.

The extension of this skeleton communications network came only after the Kinta District had passed under British rule. The gradual opening up of the country through the extension of existing communications and the building of new ones was the avowed policy of the Residents of Perak. Although many companies built their own roads to link their mines with the river, and in later years with the railway, the main transport systems were state-built. The Residents realized that without its tin Perak would have been untrodden jungle, and that for its future development a good system of communications was imperative. One of their first concerns, therefore, was the clearance of the rivers, while all surplus revenue and all the loans that could be raised were expended on the construction of roads from mining centres to these waterways. The State Government not only constructed,

1. *Perak Annual Report*, 1869, p. 28.
2. *British Empire Exhibition Series*: chapter on "The Roads of Malaya" (Singapore, 1924), p. 9.
3. The Malay word for a cluster of houses, whether hamlet or village.
4. *Perak Council Minutes*, 21 October, 1882, p. 55.

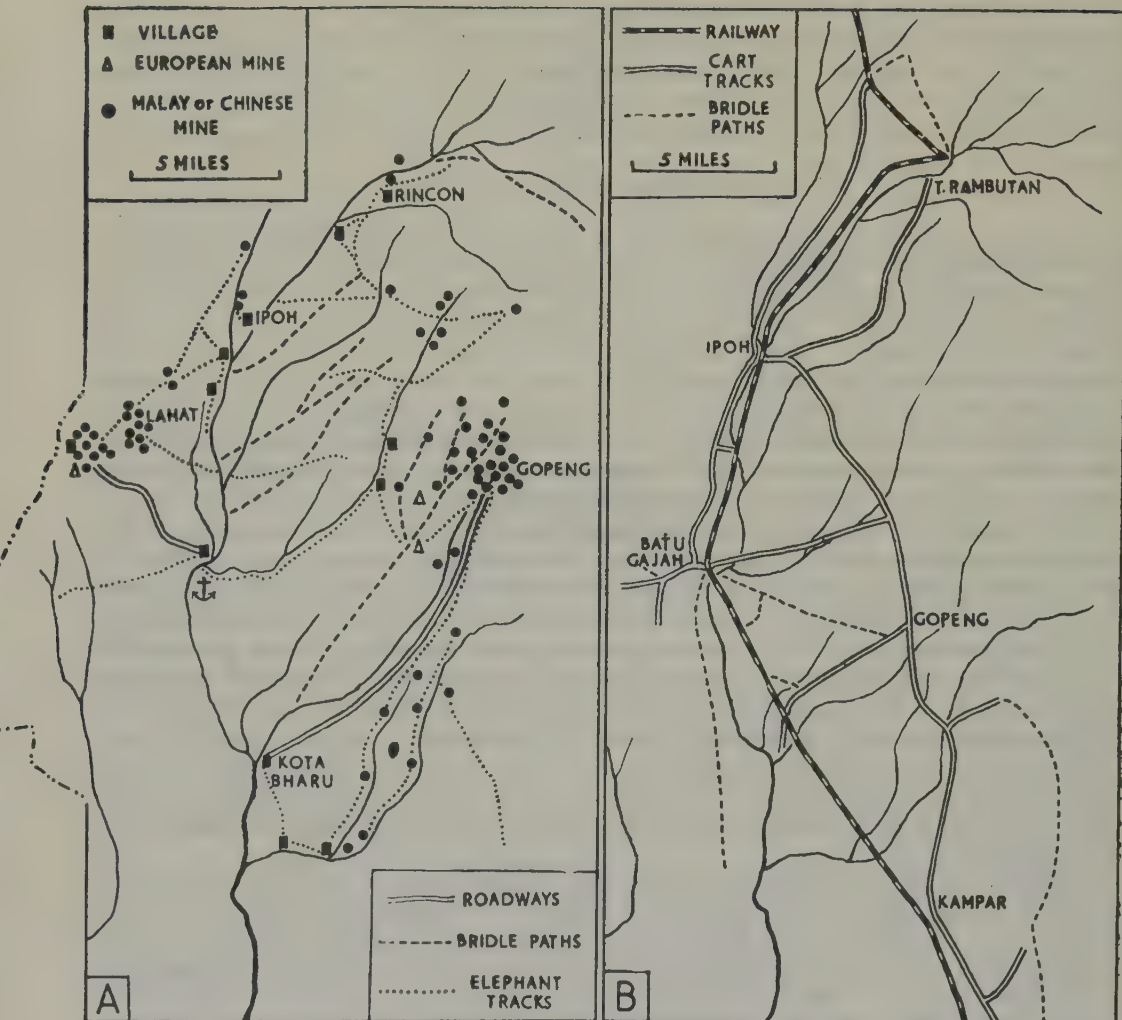

Fig. 6.

A. The distribution of mines and the pattern of communications in the Kinta Valley, 1885. Based on J. de Morgan, *Exploration dans la Presqu'île Malaise* (Paris, 1886), plate VIII.
B. The communications network of the Kinta Valley, 1901. Based on *Handbook of the Federated Malay States, 1904* (London, 1904).

improved and extended roads and water-ways, but also encouraged the building of roads by private individuals and mine owners. Indirect help was given in the form of a lower duty on tin from districts difficult of access. By means of this policy, areas remote from transport lines and the developed parts of Kinta were assessed more lightly than those near ports or navigable rivers. The reduction in transport costs brought about by the extension and improvement of roads and waterways, and later of railways, made it economically feasible to develop new and remote tin areas, the production from which led to additional revenue being provided for the further growth of the transport system. Thus a progressive spiral was created.

The early development of these transport systems was undertaken primarily to serve the needs of the mining population. It was not until the formation of the Federated Malay States in 1895 that the Government began to consider the possibility of trunk roads and through communication, together with the integration of local systems. The subsequent evolution of the communications network of the Kinta Valley was the result of state planing on a country-wide scale, and the main roads and railway line were parts of the trunk systems serving the whole of the western part of the Peninsula.

The Kinta Valley Railway Line

The first phase in the evolution of the modern transport network began with the building of the Kinta Valley Railway Line. This was conceived as a direct route from Ipoh, the mining centre, to Telok Anson. In 1888 Sir Hugh Low wrote: "I do not expect greater development of the tin industry until facilities of transport are afforded, which will be available as soon as the railway from Telok Anson to Ipoh, now determined upon, and being surveyed, is constructed. This will traverse tin deposits along its whole length of 75 miles"[1]. In the following year Swettenham added: "The first and main objective of this Kinta Valley Line is . . . to give the miners and traders of the Kinta District a better means of transport than they possess in the difficult and dangerous Kinta River."[2]

The building of this railway was a government project, and all railway construction in Kinta, and indeed throughout the Federated States, was undertaken by the Federated Malay States Railways, either departmentally or at piece-work rates under the supervision of railway engineers[3]. Work on the Kinta Valley Line began in 1891, and in 1893 the line from Telok Anson to Tapah Road (sixteen miles) was opened to traffic. At the same time the eight miles of line from Ipoh to Batu Gajah was completed. The next year the Tapah Road section was extended to Talam, seven miles to the north, while the stretch from Ipoh to Batu Gajah was continued to Kota Bharu. In 1895 the entire project was completed, the two ends of the line meeting at Kampar and thus linking Ipoh with Telok Anson[4].

The flatness of the terrain in the Kinta Valley did not present any serious obstacles to the construction of the railway line. The technical difficulties encountered were concerned with the bridging of rivers and the raising of the line above the general level of the swamps. The bridge across the Sungei Bidor was then the longest attempted in the Peninsula, being 550 ft. in length, and the sinking of foundations presented considerable difficulties. The bed of the Sungei Bidor consisted of mud from 50 to 80 ft. deep, and to provide the necessary length, five spans of 100 ft., with two approach spans each of 30 ft., were required[5]. Apart from this the line had to cross the Sungei Batang Padang at two places, as well as the Sungei Kampar, the Sungei Teja, and the Kinta River at Batu Gajah and Ipoh.

In 1896 the Kinta Valley Line was extended to Tanjong Rambutan, another mining centre eight miles north of Ipoh, and a few months later to Chemor. It was then joined to Sungei Siput town, and later extended to Kuala Kangsar to provide through communication from Prai to Ipoh and Telok Anson. Meanwhile, the line at Tapah Road was extended to Bidor and from there to the Perak-Selangor boundary where it eventually linked up with the section from Kuala Lumpur to Seremban. By 1903 a trunk line between Prai and Seremban passed through the Kinta Valley, with branch lines to Port Weld, Telok Anson, Port Swettenham and Port Dickson. Between 1908 and 1909 the Valley network of rail communications was further expanded when a local line, fifteen miles in length, was consstructed between Ipoh and Tronoh. This linked together the towns of Menglembu, Lahat,

1. H. (later Sir Hugh) Low, *Perak Annual Report, 1888*, in *Dispatches from the Secretary of State* (1889), p. 45.
2. F. (later Sir Frank) Swettenham, *Perak Annual Report, 1889* in *Dispatches from the Secretary of State* (1890), p. 19.
3. *Fifty Years of Railways in the Federated Malay States, 1885–1935* (Kuala Lumpur, 1935), p. 29.
4. op. cit., p. 56.
5. Ibid.

Papan, Pusing and Siputeh in a very important mining region. With the completion of the Kinta Valley Line, goods which had previously been brought up the river on launches and then transported by elephants and bullock-carts to the various mining areas, could be carried cheaply by rail as far north as Ipoh. Thence they were distributed throughout the district. Hitherto the difficulty of transporting heavy machinery by river had prevented any large-scale expansion of mining in Kinta, but the opening of this railway line greatly facilitated the introduction of machinery and coincided with the entry of European companies into the mining field.

As the river lost its importance as a means of communication, so existing roads were gradually diverted towards the railway. The cart-track which formerly linked Kota Bharu on the Kinta River with the mining region of Gopeng, for example, was diverted to the Kinta Valley Line, and ceased to have any connection with the port which, owing to the shallowness of the river, became inaccessible to steamers. New roads were also built to connect local mining centres with the railway, and the transport network underwent some modification. Whereas the Kinta River had formerly been the arterial highway of the district, the Kinta Valley Railway now took its place, but as the railway followed the valleys of the Kinta and its tributaries, this did not alter the fundamental pattern of the communications system (Fig. 6B).

The Present Transport Network

The final phase in the evolution of the transport pattern of the Kinta Valley began in 1902 with the appearance of the first motor-car in the region[1]. Previously roads had been constructed mainly with the object of maintaining a gradient negotiable by bullock carts, but with the introduction of the motor-car, a systematic overhaul of the roads was started. The standard aimed at was a metalled surface 16 ft. wide with no gradient outside mountainous areas to exceed one in forty[2].

The road network was designed to serve the railway rather than to compete with it. The main roads constructed in Kinta were, like the railways, financed by the State. Many of them followed the old cart-tracks, so that they were often sinuous and indirect[3]. The construction of the main trunk roads connecting Prai to Malacca was completed during the first decade of the present century. These roads pass through the Kinta Valley and form a pattern roughly complementary to that of the rail network (Fig. 7), being aligned in a north-south direction and following the valley bottoms The fluidity of movement along roads, in contrast to the rigidity of the railway system, resulted in the increasing use of roads as lines of movement within the Kinta Valley. The railway, however, did not lose its importance as a cheap medium for the transport of bulky machinery and tin-ore.

The influence of tin mining in the shaping of the contemporary road pattern can be judged by the fact that the main thoroughfares run from north to south along both sides of the valley in the foothill zones, where the richest tin deposits are found. At intervals these are inter-connected by short latitudinal lines. Numerous cart-tracks and bridlepaths radiate from these first-class roads and join the mines to the main system. These short links end abruptly at the mining sites, and may be abandoned as the miners shift their attention to another locality (Fig. 7). The transport network of both rail and road centres on Ipoh, which is the economic as well as the political centre of Kinta and the State of Perak. Other important junction towns are Chemor and Tanjong Rambutan to the north of Ipoh, and Batu Gajah and Kampar to the south. As the deposits in the foothills are worked out there is a slow but perceptible migration of activity towards the central portions of the valley

1. *The Roads of Malaya*, p. 9.
2. Ibid.
3. *First Report of the Federated Malay States Transport Board, 1936–8* (Kuala Lumpur, 1938), p. 2.

and the Kinta River. This movement towards the river, however, has not caused a rejuvenation of traffic along the Kinta River, which has become too shallow for powered boats. The transport pattern thus remains much the same as in the early years of the century, although the main roads are now some distance away from the chief dredging centres.

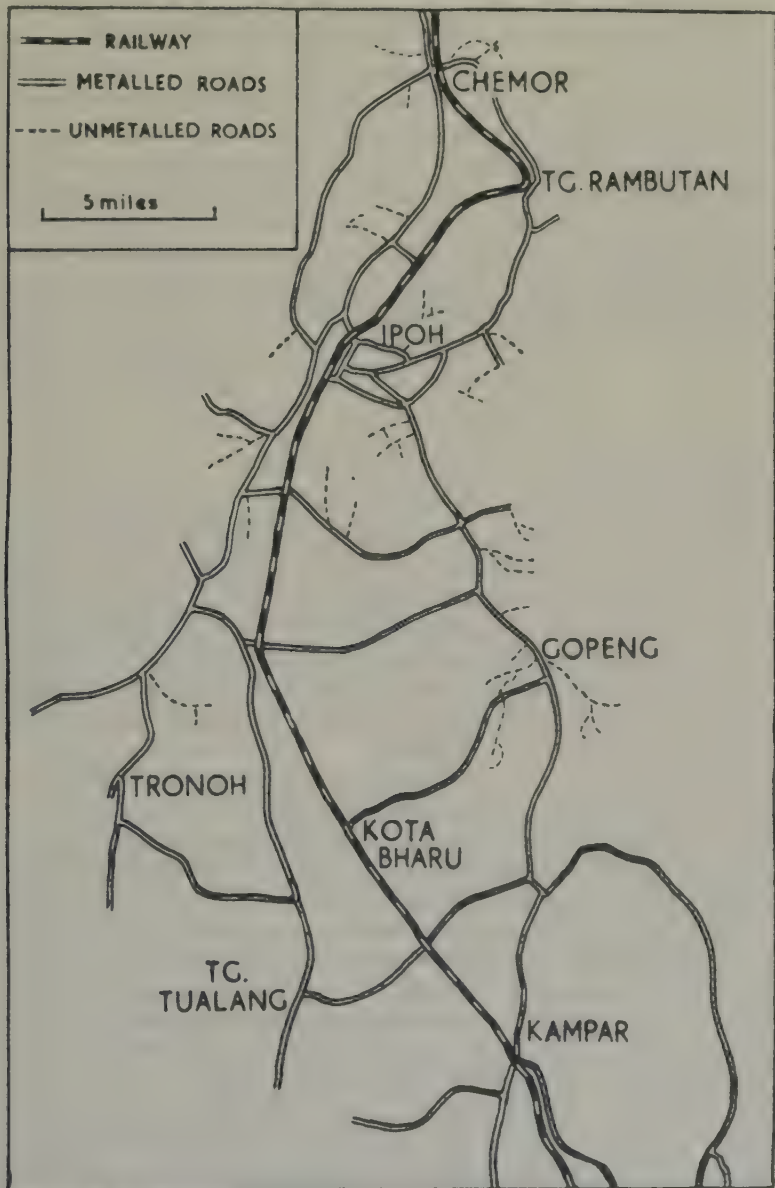

Fig. 7. The communications pattern in the Kinta Valley, 1953. Based on *Hind 1076*, 1: 253, 440, Sheets *2M* and *2N*, First Edition.

CHAPTER IV

THE EXHAUSTION OF RESERVES

Rejuvenation through Technical Impromevents

In connection with mineral resources the term "exhaustion" is nearly always used in a relative sense. Continued exploitation of a mineral ore results, under any given system of mining technology, in steadily diminishing production, and eventually mining becomes too costly to repay the capital expended on it. Exhaustion thus depends on costs in relation to the amount of ore recoverable by current techniques. In Kinta, certain areas which were at one time considered to be exhausted have been subsequently re-opened for production as improvements in mining technology have coincided with favourable prices[1]. In 1916, for example, the *Ipoh Tin Dredging Company* was working old mining lands that had once been abandoned, probably because they were too wet and swampy to be exploited by earlier mining methods. The ore was distributed more or less evenly throughout the old tailings, but the better values were found at a depth of from 30 to 50 ft., and were thus inaccessible until a special technique of digging in water-logged areas was evolved[2]. Each major improvement in mining technique has thus meant not only an increase in production, but also the possible rejuvenation of abandoned lands.

The first important advance in mining technology was the introduction of the Chinese chain-pump, which enabled miners to dig deeper and which therefore opened up new reserves of ore hitherto inaccessible to them (See p. 17 above). The introduction of the centrifugal steam-pump in turn made available tin reserves situated at a considerable distance below the water-table and unobtainable by methods employing the primitive chain-pump (p. 18 above). A further advance occurred when bucket-dredging was introduced into the tin-fields, thus bringing within the scope of practical exploitation low-lying and swampy areas, as well as low-grade areas which had hitherto been considered too poor in tin values to be worth mining at all (p. 19).

Rejuvenation of exhausted areas resulted not only from advances in the technique of ore extraction, but also from improvements in the methods of ore recovery. The revival of mining activity in Kinta during the early part of the eighteen-nineties is an example of such rejuvenation. Up to the end of 1890 the final washing of tin-ore was done in a *lanchute* or washbox. The preliminary concentration was usually done in a *palong*. The ore was then placed in the *lanchute*, for the operation of which two streams were required. This method also needed a considerable head of water, and a six-inch steam-pump could supply only enough water to keep two such *lanchutes* at work[3]. The outcome was that only land in the vicinity of large streams could be worked. Where these were not available steam-pumps had to be erected, which required large capital outlays, usually beyond the means of miners in a region that was still in the pioneering stage of development.

The solution to this problem came through the introduction of the short washbox (Malay: *lanchute kechil*), which though simple in its working, nevertheless effected an almost revolutionary change in the system of alluvial mining in Kinta. The *lanchute kechil* was only eight feet long as against the original thirty feet, but the advantages it had over the older type were out of all proportion to the difference in length. Instead of requiring a

1. See, for example, J. D. Rodger, *Perak Administration Reports 1899*, p. 20.
2. A. C. Perkins, op. cit., p. 1.
3. Everitt, op. cit., p. 86.

large supply of water from a stream or a steam-pump, it could be operated by water supplied by one man ladling with a kerosene tin. This meant, in effect, that the miners were freed from their earlier restricted choice of mining sites, and large areas of land which had been passed over as unworkable because of an inadequate supply of water could now be exploited. Other advantages were the comparative ease with which this *lanchute* could be set up and, above all, its cheapness. In the older mines employing the original *lanchute*, the overburden had to be stripped off before the payable *karang* could be mined: with the *lanchute kechil* both the overburden, containing only small concentrations of tin-ore, and the *karang* at a deeper level, could be worked simultaneously, thereby effecting a considerable saving in capital and machinery[1]. With the introduction of the *lanchute kechil*, land in Batu Gajah which had once, owing to lack of water power, been considered unworkable, became the scene of intense mining activity. In 1891 it was estimated that eighty washboxes of the new type, employing over 1,000 men, were at work there. Within the space of six months applications were filed for mining licences covering 900 acres, and the landscape underwent significant changes as mining camps were set up and roads and paths constructed. The same sequence was repeated in Tanjong Toh Allang, where mining activity, which had ceased in 1890, was resumed in 1891. And in Kampar a sudden influx of miners using the new system resulted in a trebling of the population in 1891[2].

The Rate of Exhaustion

The above discussion on the temporary exhaustion of stanniferous areas and their subsequent rejuvenation as a result of an advance in mining technology represents only one facet of the problem of the exhaustion of reserves. The number of times an area can be mined is limited, and it is unusual for a field however rich, to be re-worked more than twice. Examples do exist of areas being worked as often as four times, but these are exceptional. Although there is no means of determining the precise amount of tin-ore available in the Kinta Valley for extraction by contemporary techniques, we do know that the total quantity of tin concentrate mined since the first production records were inaugurated in 1880 is a very substantial figure. During the fourteen years from 1880 to 1893, Kinta produced 993,829 piculs of concentrate, and in subsequent years production increased to an annual figure of about 500,000 piculs[3].

Estimation of ore reserves can only afford a very rough indication of the life of tin mines, because of fluctuations in the output of each mine from year to year. In 1927, for instance, nineteen dredging companies in Kinta compiled statistics giving the area of each mining property. the estimated ore reserves and the estimated annual output, and from these calculated the life expectancy of each mine (Table 4) and a probable year of exhaustion. With due allowance being made for the war years (1942–5), when mining operations ceased, it was found, on checking with the list of dredges in operation in July 1953[4], that two companies (the *Malayan Tin Dredging Company* and the *Pengkalen Tin Dredging Company*) which should have gone out of production as early as 1927 and 1930 respectively. were still mining in Kinta. Several reasons may be advanced for this apparent inconsistency. For instance, the companies may have acquired new ore reserves and therefore extended their period of operations. Also variations in annual output due to fluctuations in the price of tin may have had profound effects on the rate at which reserves have been exhausted. These are only two examples from the several hundred mines in Kinta, but they serve to illustrate the difficulty of forecasting the precise date when the mines will be finally exhausted.

1. P. Doyle, *Tin Mining in Larut* (London, 1879), p. 14.
2. *The Straits Times*, 8 August, 1892 and "Annual Report of the Kinta District, 1891", in *Perak Annual Report, 1891* (Batu Gajah, 1892), pp. 15–6.
3. 590,362 piculs in 1952.
4. Unpublished information supplied by the *Department of Mines*, Ipoh.

TABLE 4: DREDGING COMPANIES IN KINTA IN 1927, WITH THEIR ESTIMATED ORE RESERVES

Name	Founded	Property (Millions of cubic yards)	Estimated ore reserves (Tons)	Estimated annual output (Tons)	Estimated life of mine (Years)	Estimated year of exhaustion	Whether existing in 1953
1. Ampang (Perak) T. D. Ltd. ..	1926	26.00	9,285	579	16	1942	No
2. Ipoh T. D. Ltd.	1913	21.77	8,420	600	14	1927	No
3. Jelapang T. D.	1925	20.00	7,358	500	15	1940	No
4. Kinta Kellas T. D. Ltd. ..	1926	32.00	8,570	347	25	1951	Yes
5. Kinta T. D. Co.	1924	40.50	15,670	590	26	1952	Yes
6. Kramat T. D.	1926	43.00	10,750	540	20	1946	No
7. Kuala Kampar T. D. ..	1925	50.00	17,857	578	31	1956	Yes
8. Malayan Consold. T. D. ..	1926	32.21	11,500	927	12½	1939	No
9. Malayan T. D.	1911	110.60	28,970	1,530	19	1930	Yes
10. Malim Nawar T. D. ..	1923	30.00	9,285	400	23	1943	No
11. Malim Nawar T. D. (South) ..	1923	50.00	16,370	530	31	1953	No
12. Pengkalen	1907	800 acres		850	20	1927	Yes
13. S. Malayan T. D.	1926	90.00	21,428	770	27¾	1954	Yes
14. S. Perak	1920	60.00	15,000	700	21½	1942	No
15. S. Kinta T. D.	1925	30.80	12,925	510	25	1950	Yes
16. Tanjong T. D.	1926	35.50	9,930	360	27	1953	Yes
17. T. Tualang T. D.	1926	50.00	17,857	578	31	1957	No
18. Teja Malayan T. D. ..	1925	73.66	21,920	1,446	15	1940	No
19. Tronoh Mines	1901	5,100		1,660	..	..	Yes

Compiled from a *List of Tin Companies in Perak* (Singapore, N.D.) and from information supplied by the *Department of Mines*, Ipoh.

Fermor gives the average life expectation of the tin mines in the Federated Malay States as twenty years from 1938[1], but so complex are the factors to be considered that any attempt to predict the year when tin will cease to be mined in Kinta can be only conjectural. First there is the technological factor discussed above. Improvements in technology affect the time-scale of exhaustion in two ways: (1) they may result in a rejuvenation of areas hitherto regarded as exhausted, and (2) they may bring within the scope of practical mining areas which have previously been inaccessible. The introduction of dredging into Kinta, for example, brought into the mining field swampy lands which had hitherto remained untouched, and thus increased the available ore reservees of the region. At the present time,

1. Sir Lewis Fermor, *Report upon the Mining Industry of Malaya* (Kuala Lumpur, 1939), pp. 119–20.

however, only a very small percentage of ore escapes ultimate recovery in any given mining-field, so that exhaustion usually approaches the absolute. In the early days of mining, on the other hand, a good percentage of ore invariably escaped the concentration plant, and many areas could profitably be worked again when high prices justified such an outlay, and when technology improved sufficiently to allow recovery of the residual ore. With contemporary techniques, which fail to extract only a small amount of tin, the likelihood of future rejuvenation becomes increasingly remote, so that the date of ultimate exhaustion of any particular ore reserve is brought much nearer.

The second factor affecting the time-scale of exhaustion is the world demand for tin, for production varies annually according to this demand. The area of land being mined and the intensity with which it is worked depend ultimately on the decisions of entrepreneurs, who are in turn influenced by the economic incentive to produce more or less as the case may be. To produce more tin-ore, both the extent of land worked and the intensity of production are increased, leading to a proportionately larger area of land being exhausted, and thus bringing forward the period of ultimate exhaustion. The difficulty of forecasting the life of tin mines is described by Scrivenor as follows: "What the life of the tin-fields of Malaya will be no one can gauge with any degree of accuracy. Even if we could know the total amount of tin-ore, two other factors are required to form an estimate, the cost of power and the efficiency of the methods employed in the future. The last phase will be much the same as the state of the Cornish Mining Industry today, entirely lode-mining, when all the detrital deposits are exhausted, but who would venture to say when that will be?"[1].

Prospecting

Prospecting for new areas of stanniferous deposits is intimately related to the whole problem of exhaustion, the only adequate remedy for which is the discovery of new areas. New reserves acquired in this way are, unlike rejuvenated fields, definite additions to the total amount of available tin-ore, Since the nineteen-thirties there has been only intermittent prospecting for new deposits even though existing reserves are being steadily worked out, so that now the discovery of new tin-fields is a matter of urgency. The absence of large-scale and systematic prospecting during these years was due not to any ignorance of the imminent exhaustion of the proved reserves, but to uncontrollable external factors. During the 1929–30 season, when the first effects of the Great Depression were becoming evident, there was over-production of tin, and restrictions were placed on the alienation of land for mining. In the following year, there was compulsory restriction of production, and, as a consequence, the policy of limited alienation of land for mining was still more strictly enforced. This state of affairs lasted until just before the outbreak of war in 1941, when every effort was made to increase production, but from existing fields rather than by prospecting for new ones.

The four years of the Japanese occupation saw only limited mining activity and no prospecting whatsoever. Immediately after the war attention was focussed on rehabilitation, with companies engaged in efforts to bring their mines back into production, and consequently not in a position to undertake any long-term prospecting. The alienation of land up to September, 1947 was limited to that required for the maintenance of existing undertakings, or to the granting of pre-war applications. Only at the close of this period of rehabilitation was prospecting attempted, but when a state of emergency was declared throughout Malaya in 1948 such activities ended abruptly. With the slight improvement in

1. Scrivenor, *The Geology of Malayan Ore-Deposits*, p. xiv.

conditions in 1953, "a limited amount of prospecting is being undertaken in certain areas under the protection of armed guards"[1]. In 1954 the situation remains much the same as in the previous year.

Potential Reserves

There are at present five potential sources of tin in the Kinta Valley.

(1) Malay reservations, forest reserves, river reserves, agricultural land and other holdings which have been selected by the Government for purposes other than mining. It was such reserves that the Chief Inspector of Mines of the Federation of Malaya had in mind in 1949 when he wrote: "Whenever an ore-deposit is covered by schemes directed to other purposes, it is more than likely that, in the future, economic pressure will force the abandonment of such schemes in favour of mining with its higher returns"[2]. More than a decade previously the President of the Federated Malay States Chamber of Mines had voiced a similar opinion: "It would seem logical . . . that where agricultural land is tin-bearing every effort should be made to develop alternative agricultural areas on land which is of no value for mining purposes, so that the tin-bearing land can be made to yield its wealth for the benefit of the country"[3].

Moreover, it is not only agricultural land which may be tin-bearing, but also river beds, which have often proved rich in ore transported from higher stanniferous land. In 1927 a Commission was appointed to investigate, among other things, this question, and one of its findings was that, ". . . it is advisable to win tin from river beds and adjacent land by dredging provided reasonable safeguards are provided"[4]. As a result of this recommendation, three large mining companies negotiated with the Government for the diversion of the Kinta River to facilitate the recovery of tin-ore lying beneath its bed. These negotiations, which had been started before the War, were completed only recently, and the project was put into execution in 1950, the expense being defrayed by the Government and the mining companies concerned, namely the *Pengkalen Company, Ltd.*, the *Malayan Tin Dredging Company, Ltd.*, and the *Southern Kinta Consolidated, Ltd.* The scheme includes the straightening and diversion of the Kinta River from Ipoh to Kuala Chenderiang (Figs. 8 and 9). At the end of 1951 canalization was completed for parts of the river immediately below Ipoh, for that section where it is joined by the Sungei Raia, and for a section of the Sungei Kampar. Five hundred thousand tons of ore are expected to be recovered from fourteen miles of the old river bed[5].

(2) The second category of potential tin sources in the valley includes extensive swamps and jungle around the lower reaches of the Kinta River and low-grade ground in or adjacent to existing mining areas. Both these types of land have been passed over previously because of the high costs of extracting ore from them, but in the future they can probably be systematically worked by large-scale, efficient methods, such as dredging. The exploitation of these areas thus depends on a continuing demand for tin, and also on improvements in mining technique.

(3) The third source of stanniferous deposits in Kinta is that at present hidden under a thick mantle of deposits at river mouths and even out to sea. However, nothing is known as yet regarding the presence in this region of tin-ores similar in size or grade to those around the islands of Banka and Billiton, where 'drowned' deposits are covered with recent alluvium averaging only 50–60 ft. in depth. These deposits were laid down before the sea rose to its present level and covered them with alluvial blankets, whose thicknesses vary

1. Statement of the Chairman of the *Malayan Tin Dredging Company, Ltd.*, and of the *South Malayan Tin Dredging Company, Ltd.*, at the Annual General Meeting, 1953: *The Straits Times*, 7 Jan., 1954.
2. *Federation of Malaya Annual Report, 1949* (Kuala Lumpur, 1950).
3. Report of the President of the Federated Malay States' Chamber of Mines for 1937, in *F.M.S. Chamber of Mines Year-Book 1938* (Kuala Lumpur, 1938), p. 29.
4. *Report on Rivers in the Federated Malay States* (Kuala Lumpur, 1928) p. 26.
5. *Brown's Economic Review*, Vol. 1, No. 16 (Singapore: 31 Aug., 1951), p. 5.

according to the size of the rivers that brought the sediment, and according to their location[1]. It is difficult to distinguish such areas in Malaya, where changes in sea-level have exceeded 100 ft. and where in places the depth of the alluvium exceeds 450 ft. But there is at least one region in Malaya where a tectonic axis passes under coastal alluvium, and where tin has been proved to occur. This is the Kledang Range and its southerly prolongation, and prospecting is likely to reveal extensions of the stanniferous deposits in this area.

(4) Included under the category of deep ores such as those described above are tin deposits in limestone that are at present situated at such great depths that it is not practicable to work them by existing methods[2]. The depth of the limestone floor in the centre of the valley is not known, but on Pulau Langkawi the limestone has been proved to be 5,000 ft. thick. As Kinta is flanked by two granite ranges, it is not unlikely that there is granite beneath the limestone floor of the valley. The granite-contact zones on the flanks of the valley have been proved to be richly stanniferous, and hence there is the possibility that the same conditions hold good for the contact plane between the limestone floor and the deep-seated granite beneath it[3]. The future exploitation of this source of tin is again dependent on working costs and on technical improvements, as well as on a change from alluvial to lode mining.

Another proved source of ore worked at present is the pipes and veins within the limestone floor of the valley. In the past the *Jehosophat Mine* was extracting ore from such pockets. The difficulties encountered included: (i) the necessity for continuous shaft-sinking, which made for a low tonnage *per diem*; (ii) the presence of impurities in the form of metallic sulphides, which necessitated a preliminary roasting before the ore could be smelted; and (iii) the difficulty of prospecting in the solid rock of limestone areas.

(5) A likely future source of tin is the parent veins and lodes in the granite ranges flanking the Kinta Valley. So far only one lode-mine has been operating in the region, the *Menglembu Lode Mining Company*, which is extracting tin from veins and lodes in the Kledang Range. However, there is abundant evidence to indicate the presence of workable quantities of ore in the granite ranges, which have not so far been worked only because the detrital ores in the valley proper have been more attractive propositions[4].

The two main granite ranges bordering the Kinta Valley, including the Bujang Malaka mass, may be regarded as *potential mining areas*. Large-scale exploitation of these regions may be possible if tin remains in demand when lowland detrital deposits are exhausted. This will mean a shift in emphasis from lowland to upland mining, from the working of tin by shallow alluvial methods to lode-mining, and consequently a complete change in the tin-mining landscape. The present mining features, such as shallow excavations with wooden scaffoldings, or large floating dredges, will then give place to the appurtenances of shaft-mining, such as are now associated with Cornwall and the Altiplano of Bolivia.

1. E. S. Willbourn "Notes on Tin Deposits in Malaya", *Federated Malay States Chamber of Mines Year-Book, 1940* (Kuala Lumpur, 1940), Appendix *K*, pp. 120–6.
2. Scrivenor, op. cit. p. xii.
3. J. B. Scrivenor, "Annual Report of the Geological Department, 1925", in the *F.M.S. Annual Report, 1925* (Kuala Lumpur' 1926), Appendix 2.
4. Scrivenor, *The Geology and Mining Industry of the Kinta District*, p. 73.

CHAPTER V

EROSION AND SILTING

THE PATTERN of mining activity in the Kinta Valley has taken two forms: (1) uncontrolled exploitation of the mineralized areas: this was characteristic of the early days of settlement when the country was still in state of political flux and there were no laws to regulate mining; (2) systematic extraction of ore, with legislation controlling the more destructive phases of mining activity. This is characteristic of mining at the present time. But whatever form it takes, the exploitation of minerals is always a destructive occupation of the land. In the first place it is impossible to replace the materials extracted; and in the second, the ore can only be obtained by excavation, which implies drastic alterations of angles of slope, and often disturbs the balance of nature, especially through the destruction of forests, and the normal soil profile.

The effects of the first phase of mining activity in Kinta,that of uncontrolled exploitation, are still in evidence today, as witnessed, for example, by the periodic flooding of the low-lying section of Ipoh, and by the gradual silting up of the river mouth at Telok Anson The situation was admirably explained in a Government publication of 1928: "While a variety of factors have contributed towards the deterioration of rivers in Malaya, there is no one factor which has played a more important part than the presence of large quantities of sand, resulting from mining operations, in the beds of a number of rivers and their tributaries. The control of tailings was, in early days, perfunctory and ineffective, and today the country is faced with the problem of dealing by curative measures with a disorder which in the nature of things is peculiarly amenable to preventive measures, and which, had adequate preventive measures been taken in the past, need never have attained very serious proportions"[1].

DAMAGE BY MINING

The damage that has been inflicted on the landscape by uncontrolled mining can be divided into: (1) that caused by all forms of mining in general, and in particular by ground-sluicing or *lampanning* on hill-sides; and (2) that caused by the discharge of tailings from modern mines into the drainage system of the valley.

In early days mines were concentrated on the slopes of hills for two main reasons: drainage was better in such areas, and there were usually streams to provide the water necessary for mining operations. The usual method was *lampanning*, a system whereby the surface of the ground was "skinned" of its *karang* by sluicing. This operation itself inflicted severe scars on the landscape, but even more important were the effects of the preliminary jungle clearing, for denuded of its protective vegetation, the soil of the hill-sides was an easy prey to erosion. As the accumulated top-soil and most of the weathered material beneath were washed away, leaving only the core-boulders and partially weathered rock, such land took many years to return to its original state. These activities resulted in a constant discharge into the drainage system of the area of large quantities of silt, varying in texture from coarse sand to fine slime, so that eventually the river beds were raised above the level of the surrounding country. Whereas in earlier years the river overflowed only at exceptional periods, floods now became the normal concomitant of heavy rainfall around the headwaters of the Kinta and its tributaries. This periodic flooding has deposited extensive areas of alluvium in the lower reaches of the river. With continuous accumulation

1. *Report on Rivers in the Federated Malay States*, pp. 7–8.

these have become almost permanent swamps, under water during the wetter months of the year. In addition, silting of the rivers has led to the inundation of towns and villages situated on the flood-plains. Ipoh, in the nineteen-twenties, before the initiation of the *Flood Retention Scheme*, was periodically flooded by waters from the Kinta River, so much so that the decision in 1927 to make it the capital of Perak rested ultimately upon the possibility of controlling the annual floods, which were particularly serious in the centre of the town[1].

Another consequence of unrestricted mining was the reduction of once flourishing agricultural areas to desolate wastes, as rivers distributed over the land enormous quantities of sand and silt from the mines. One such area was that stretching from Kampong Kepayang along the Sungei Raia to the Kinta. Here a well-kept rubber estate was reduced to long stretches of dead trees, *belukar*[2] and swamp-grass, while the lower reaches of the river were converted to muddy lagoons[3]. The Sungei Raia was also the cause of the flooding which frequently rendered the road from Batu Gajah to Gopeng impassable.

The era of unrestrained mining continued for some years after the establishment of the first European companies. The development of new techniques, based to a large extent on the use of machinery, coincided with an increased demand for tin by the industrial world, and this led to a steady and progressive rise in production. Kinta, which yielded only 14,738 piculs of concentrate in 1880, by 1892 was the largest producer in Malaya, with 192,671 piculs, or more than two-thirds of the total production of Perak[4]. In that year, too, a European firm introduced the new system of hydraulic mining, whereby water was used for excavation and recovery[5]. Hydraulicking usually takes place near a perennial stream and locations on hill-sides are common. The hydraulicking process, too, produces a considerable quantity of tailings and, before these were compulsorily controlled, hydraulicking was among the chief contributors of silt to the rivers.

Methods of Control

The *General Land Regulations* introduced in 1879 were not meant to be restrictive, except in so far as the diversion of water from a stream or reservoir required Government permission. The first serious attempt to restrict indiscriminate mining was made in 1895 with the passing of the *Mining Code*, which gave the Warden of Mines power to exercise greater control over mining methods. The waste products of tailings, sand and slimes from the hydraulic workings were to be settled in silt retention areas or in abandoned mining holes, so that only fine slime would be discharged into rivers. No tailings were to be settled on virgin land.

The *Mining Code* of 1895 was later repealed and a new code, *Enactment No. 5 of the Federated Malay States* of 1889 came into force, which was in turn superseded by the *Mining Enactment of 1904*. With the rapid expansion of mining in the region, the need to exercise control over mining operations was becoming ever more imperative. The Public Works Department, for example, complained of damage to roads from the flooding caused by the indiscriminate discharge of tailings into rivers. As a result a *Tailings Commission* was set up in 1905, which recommended that certain rivers should be kept free from discharge, but that since it was impracticable to retain waste products wholly on the mining site, discharge of silt should be permitted on condition that bridges and culverts were not blocked. Another Enactment (*No. 12*) was passed in 1912, was revised and came into operation in 1914, and finally *Mining Enactment No. 19* of 1928 remains in force today. In addition, there was an important ruling in 1923 when land above the 250 ft. contour was closed

1. *Annual Report of the Drainage and Irrigation Department of the Federated Malay States, 1937* (Kuala Lumpur, 1938), p. 86.
2. The Malay name for secondary jungle or scrub.
3. *Annual Report of the Drainage and Irrigation Department of the Federated Malay States, 1936*, p. 78.
4. Wray, op. cit., p. 17.
5. p. 10 above.

to mining, and it was recommended that no hilly region should be worked until the flats below had been mined and could, therefore, subsequently be utilized as tailings retention areas. *Lampanning* in hill areas in Perak was forbidden after the end of 1921 unless tailings could be retained, but the act included a conditional clause applicable to those mines which could construct permanent and comprehensive tailings retention works[1].

These regulations were made solely to prevent the total devastation of whole countrysides by clearance of the protective forest cover and by the haphazard discharge of silt, but they have not unnaturally led to conflict between mining interests and the various governmental departments concerned with land, agriculture, forestry and drainage; and this and subsequent chapters will be dovoted to an analysis of these problems.

All forms of mining in Kinta produce large volumes of waste matter, ranging from coarse sand and small pebbles to fine silt and slime, and varying in quantity with the method of extraction. *Dulang* washing, which accounted for only 1·17 per cent of the total production of ore in Kinta in 1952, is the exception to this rule, for the excavation and breaking up of the stanniferous deposits is here accomplished by the natural processes of weathering and erosion, after which the ore is carried down rivers and streams, whence it is subsequently recovered by the *dulang* washers. The process of *dulang* washing itself is merely the removal of the tin sand, without the addition of any extraneous matter to the rivers and streams, and the only effect is a minor disturbance of the river bed which does not appreciably affect the flow of water.

Lampanning on hill-sides was prohibited in the early nineteen-twenties because of the immense amount of silt-charged effluent it created, but the modern derivation of this indigenous method—hydraulicking—continues to produce large quantities of tailings; while the discharge from gravel-pumps is essentially the same as that produced by hydraulicking. However, the quantity is much smaller, and less water is used in the operations. Before preventive measures were introduced, dredging contributed its share of effluent to rivers, though in later days the discharge from dredges was used to fill up the portions already mined. With adequate bunding, only fine, slime-laden water was allowed to escape from the dredging area. According to the Senior Warden of Mines in 1928, only 5 per cent at most of the dredged material was discharged into the rivers[2].

Damage from Agricultural Activities

So far this discussion has been concerned with the effect of mining on the drainage system, but there is another aspect to the conservancy problem, viz., the amount of silt entering the rivers as a result of agricultural activities, especially those in the higher parts of the valley. Clearing of hill-sides by miners to provide fuel for smelting purposes, and also by aborigines practising shifting cultivation, have left their mark on the landscape, while one of the greatest contributors of silt to the rivers, apart from the mines, was the rubber estate, especially during the years when clean-weeding was practised.

On clean-weeded rubber estates the clearing of jungle and undergrowth greatly accelerated the rate of run-off of rainfall, with the result that the natural regime of the rivers was seriously disturbed. Fermor estimated that erosion on rubber estates contributed yearly to the river systems of Malaya an average of twice as much silt as did mining activities[3]; but that conclusion is not valid for Kinta, because most of the damage there was done

1. *Annual Report of Mines Department, 1921* in the *Perak Annual Report, 1921*.
2. Quoted by Fermor, op. cit., p. 154.
3. Ibid.

by the uncontrolled mining of early days, whereas Fermor based his estimates only on the period subsequent to the introduction of restrictions. Moreover, Fermor's averages were for production in Malaya as a whole, where the total ground under rubber exceeded that alienated for mining, but in the Kinta Valley mining land has always exceeded that under rubber.

This excessive sedimentation resulted in the raising of the beds of the main river and its tributaries, leading to frequent flooding of the surrounding land. As Fermor has aptly said, in these activities the miner becomes a geological agent[1], and as such he has induced at least one instance of involuntary population shift in the Kinta Valley. This occurred in a village a mile or so from the confluence of the Tumboh and Kinta Rivers. Kampong Balun Bidai in the first decade of this century had a population of some 2,000 engaged in subsistence padi cultivation, but as a result of sedimentation in the lower reaches of the Kinta, caused mainly by mining around the upper courses, the mouth of the Sungei Tumboh was gradually silted up, and water once flowing through a single channel eventually reached the Kinta by way of a number of anastomosing distributaries. Eventually the channel of the Tumboh became wholly obstructed and floods from the Kinta even flowed into the Tumboh, thus reversing the normal water movement. The area bordering the lower Tumboh was converted to a swamp, and Kampong Balun Bidai inundated. Large stretches of padi-fields were destroyed, and the normal steamer service between the village and Telok Anson had to be abandoned because boats could no longer negotiate the shallows. When only small sampans could reach the *kampong* the population began drifting away, until of the original 2,000 only 400 were left[2]. In 1937 the land was reclaimed by the construction of a canal a mile and a quarter long and 60 ft. wide, which cut across to the Kinta in a south-easterly direction, thereby obtaining the necessary gradient to induce a normal flow of water.

Similar dislocations were experienced as far upstream as Ipoh. Extensive mining operations around the Sungei Raia in the years before the enforcement of the Mining Enactment discharged vast quantities of coarse sand and gravel into the river. Subsequent conservancy operations began in the Raia gorge, where the river ran between limestone cliffs standing about 1,000 ft. above their surroundings. Here large quantities of tailings had been spread over the river, so that what was originally one deep course became a series of shallow, indeterminate channels with the appearance of a geomorphologically senile, braided river. To train the river back to its original channel bamboo fences were erected and vegetation planted with the object of stabilizing the banks.

At the point where the road from Batu Gajah to Gopeng crossed the river conservancy measures differed from those further upstream, and were confined to dredging the river channel of its excess load. The amount of silt deposited in the river was so great that in 1936 a twelve-inch dredge had to work continuously for eight months, scooping out 202,111 cubic yards of silt, before the river channel was deepened by one foot[3]. But downstream bed levels were lowered by seven feet, and some 1,000 acres of rubber land belonging to the *Kinta Kellas Company* had the benefit of better drainage conditions.

In general, river conservancy was designed to maintain normal drainage in the valley by the way of the Kinta River. Eventually the original channel was altered to such an extent, both by silting in the first place and then by measures to correct and prevent further damage to the flood-plain, that today the river can be termed an artificial waterway (Fig. 8).

1. Fermor, op. cit., pp. 162–3.
2. *Annual Report of the Drainage and Irrigation Department, F.M.S., 1937*, p. 87.
3. op. cit., p. 86.

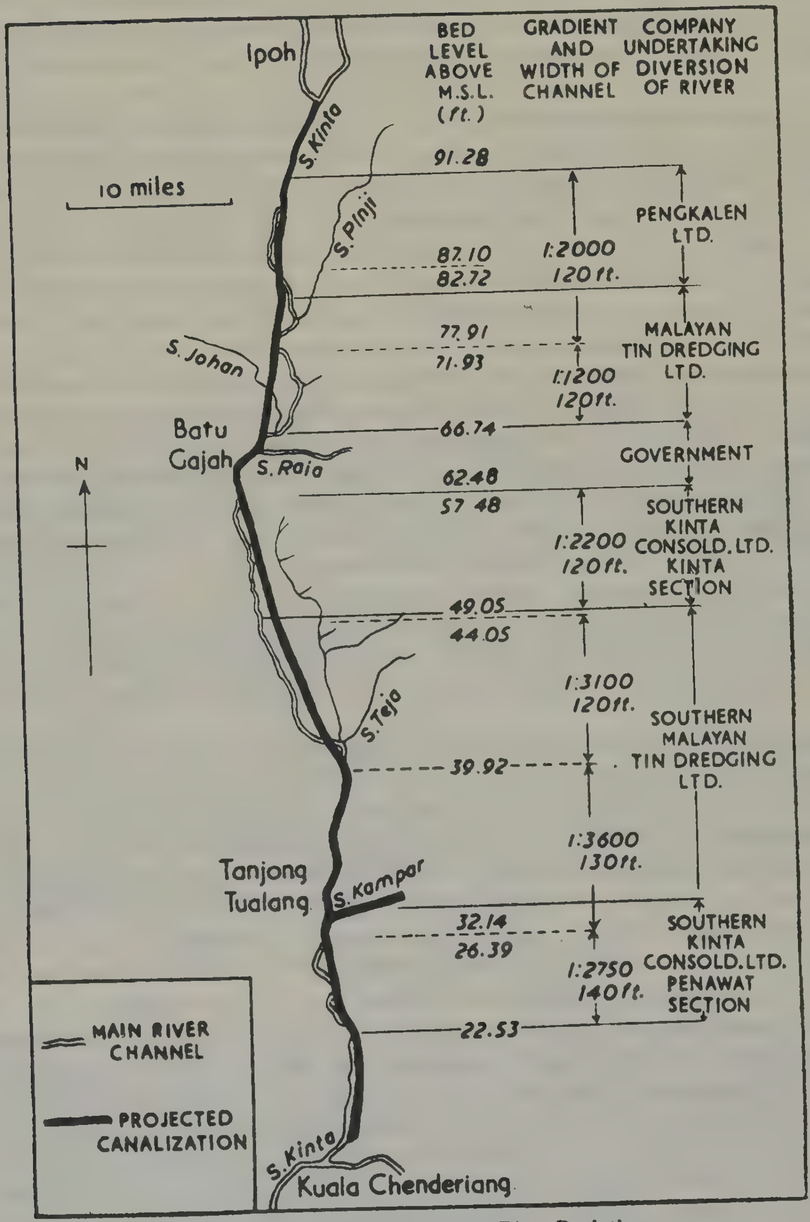

Fig. 8. Key plan of the *Kinta River Deviation.*

Based on Plan No. D.I.D. H.Q. P.K. S.D. and I.E. P.K. 10/259, supplied by the Department of Drainage and Irrigation, Federation of Malaya.

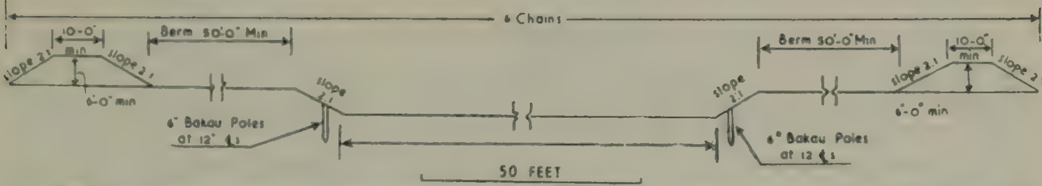

Fig. 9. Transverse section showing the proposed form of the channel of the Kinta River, with berms and lêvées. Based on Plan No. D.I.D. H.Q. P.K. 10/259, supplied by the Department of Drainage and Irrigation, Federation of Malaya.

River Conservancy Schemes

The most elaborate and costliest attempt at conservation was the *Ipoh Flood Mitigation Scheme*, started in 1928. Previously the town was inundated with water to a depth of four or five feet after every period of heavy rainfall, and was threatened with destruction similar to that which occurred at Kuala Kubu in Selangor. The worst flood recorded was that of 1926, when the water flooded even the central sector of the town, and the computed rate of discharge was 5,350 cusecs[1]. To prevent further damage to Ipoh the *Flood Mitigation Scheme* was inaugurated. It consisted of three phases:

(1) The construction of a channel passing through the town from Anderson Road to Kuala Pari to draw off flood-water with a discharge of up to 10,000 cusecs. This channel is 2½ miles long, 170 ft. wide between the tops of the embankments, and 15 ft. deep, measured from the low water channel. The completion of this part of the scheme has allowed the reclamation of 15 acres of swampland, which are now valuable building sites.

(2) The diversion of the Sungei Choh, the major source of silt. The Choh valley had been an important mining region in earlier days, and the river channel had become so badly silted up that the surrounding areas from Ipoh as far as the Pinji Road were converted to swamps. Before the construction of the diversion channel, ineffective attempts had been made to stabilize the large silt deposits in the foothills of the Choh, but now a large silt trap was constructed near Tambun. The canalization and diversion of the Choh immediately reduced the risk of flood in the Ipoh district, and also made possible the reclamation of 4,000 acres of land for cultivation[2].

(3) The clearing of the Kinta and its main tributaries of obstructions such as fallen timber embedded in the channel, elephant grass and other vegetation. This cutting of undergrowth was later found to be a mistake, as it accelerated bank scour and the establishment of a still heavier growth of reeds, which greatly impeded the flow of water.

Downstream towards the confluence of the Kinta with the Sanglop and Teja, the river flowed through an extensive swamp area, caused by silt brought down from the mines about Gopeng, and floods were common even in Kota Bharu. This stretch was later dredged, and the beds of the Sanglop and Teja lowered.

Early mining leases contained no provision regarding the right to work river channels for tin, and consequently rivers and streams were often diverted so that their beds could be dredged. It was only with the introduction of the Mining Enactments that natural drainage was afforded some protection. Subsequent mining leases excluded the right to interfere with a river course and a small reserve on either bank. Now a river can only be diverted after a satisfactory scheme is approved by the Government. In this connection, the most ambitious programme to date is the *Kinta River Deviation Scheme*, whereby three large dredging companies have been granted permission to mine the Kinta River and to divert its channel for this purpose (Fig. 8). Applications for permission to do this were

1. *Annual Report of Drainage and Irrigation Department of the Federated Malay States, 1936*, p. 86.
2. *Annual Report of Drainage and Irrigation Department of the Federated Malay States, 1938*, p. 78.

first made as early as 1925. In 1928 a *Rivers Commission*[1] was set up, which had as one of its main objectives the study of the mining of river courses, and the protection of the interests of riparian owners downstream. The Commission recommended that "... it is advisable to win tin from river beds and adjacent land by dredging if safeguards are provided"[2]. Agreements between the Government and the dredging companies concerned with the Kinta Deviation Scheme were drafted before 1941, but the ultimate decision came into affect only in 1950.

Besides introducing legislation to control mining and the disposal of tailings, in 1932 the Government created a *Drainage and Irrigation Department*. However, because most of the damage had already been done, the activities of this department were restricted mainly to repair work. Preventive measures were provided for by the Mining Enactment, and the Drainage and Irrigation Department instituted a series of curative schemes, some of which have been described above. Prior to this, the Mines Department was given the power to enforce the laws and regulations of the Mining Enactment, and to control the disposal of tailings. Miners were required to retain coarse tailings in properly constructed retention dams, and could only discharge effluent water containing less than 800 grains to the gallon into the drainage system of the country. Thus, the coarser material, which has been the major cause of sedimentation in the past, is now impounded by these retention schemes.

1. See *Report on Rivers in the Federated Malay States.*
2. op. cit . p. 26.

CHAPTER VI

MINING AND OTHER FORMS OF LAND USE

THE FACT that the ore reserves of the Kinta Valley consist mainly of shallow, detrital deposits which necessitate the extensive excavation of large areas of land, inevitably brings mining interests into conflict with other types of land use. Practically all Kinta consists of proved mining land. The only exceptions are the highlands of the Kledang and the Main Ranges, the Bujang Malaka granitic mass, and a small area between Batu Gajah and Tanjong Tualang. These highlands are all classified as *potential mining areas*, while the district between Batu Gajah and Tanjong Tualang is classified as a *possible mining area*. The only place where mining is not expected to occur is in the extreme south-west of the valley, in an area comprising less than one per cent of the total area of Kinta. As far as the existence of stanniferous deposits is concerned, therefore, there is nothing to prevent the possible extension of mining over almost all the Kinta Valley.

MINING AND AGRICULTURE

Mining is concentrated on the granite-contact zone on both sides of the valley, where the richest deposits are found. The land alienation map of the Kinta District (Fig. 10) shows that mining land at present occupies a U-shaped area, the arms of the U being the valley sides, and the curved portion the flat alluvial land near Tanjong Tualang, where dredging is the predominant method of mining. Within the arms of the U, in the central part of the valley, are the main agricultural areas of Kinta. Although mining realized a greater amount of revenue than did agriculture, the total acreage held under mining leases and titles in 1953 amounted to only 93,677, while the total area of agricultural land was 85,188 acres. Of this more than 90 per cent was under rubber, and the rest under padi, coconuts and miscellaneous crops[1]. It is not, therefore, surprising that there should be keen competition for land between agricultural and mining interests. But other important factors have to be taken into consideration which complicate this apparently simple picture of a conflict between two forms of land use. The shortage of mining land in Kinta became apparent as long ago as 1910, and by 1916 agricultural land was being converted to mining land[2]. This policy has continued up to the present period, the conversion of any particular piece of land depending upon the estimated richness of the ore, upon the prevailing price of tin, and upon the rate of exhaustion of surrounding mines. During 1948, for instance, 331 acres of agricultural land in Kinta were converted to mining, and in the succeeding year the figure rose to 385 acres. This policy has been approved by most investigators of the problem. Sir Lewis Fermor, for example, gave his opinion as follows: "The present state of prosperity in Malaya is so intimately connected with the prosperity of its mining industries that any reservation for other purposes of lands containing workable minerals should only be undertaken or allowed to continue in very special circumstances"[3]. This conclusion was reinforced by the authority of the President of the Federated Malay States Chamber of Mines in 1938: "It would seem logical therefore, that where agricultural land is tin-bearing every effort should be made to develop alternative agricultural areas on land which is of no value for mining purposes, so that tin-bearing land can be made to yield its wealth for the benefit of the country"[4].

1. *Annual Report of the Kinta District, 1953* (Batu Gajah, 1954). [Mimeographed].
2. Everitt, op. cit., p. 36.
3. Fermor, op cit., p. 174.
4. Report of the President of the Federated Malay States' Chamber of Mines for 1937 in the *F.M.S. Chamber of Mines Year-Book, 1938* (Kuala Lumpur, 1938) p. 29.

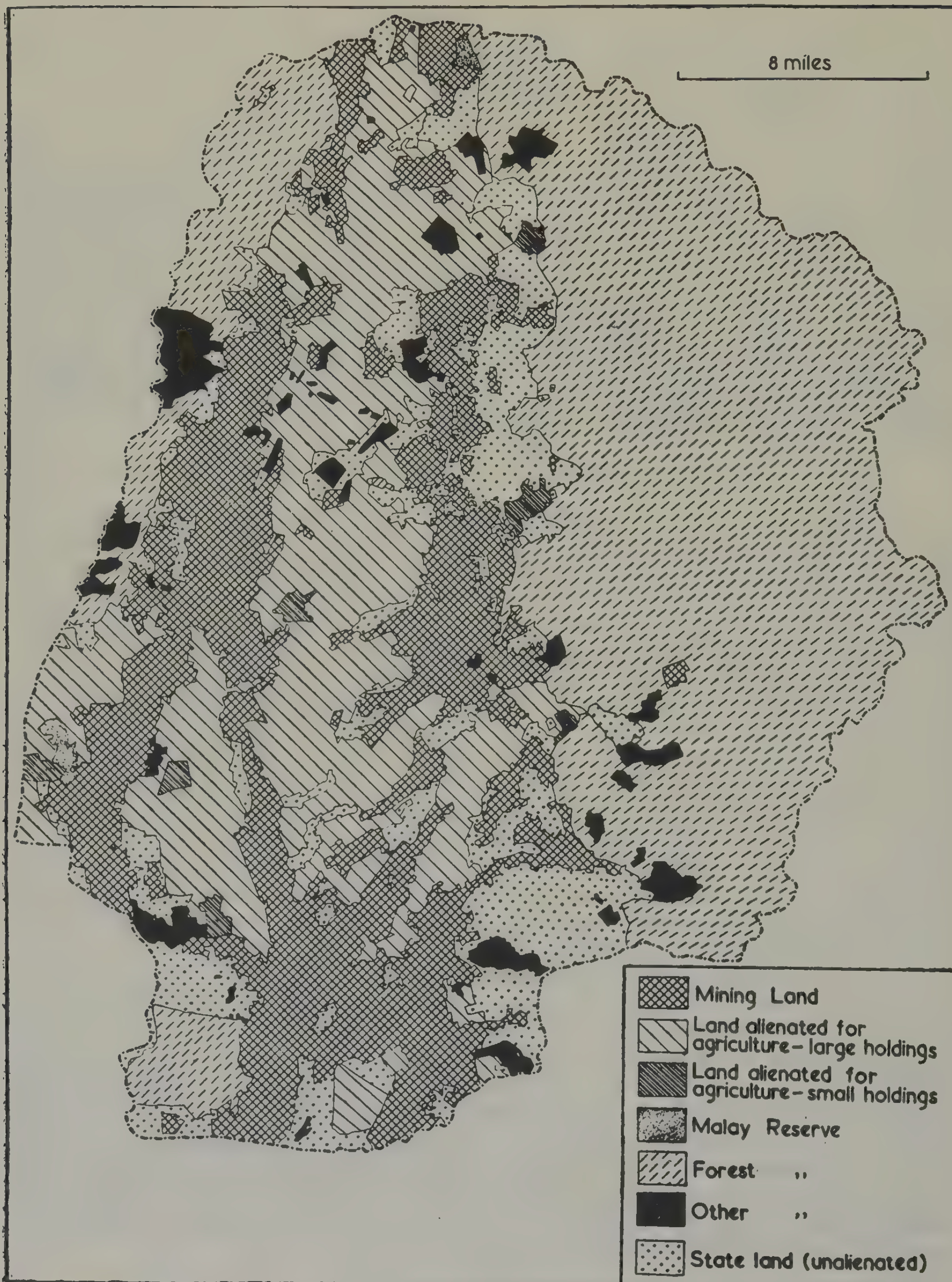

Fig. 10. Land alienation in the Kinta District, 1951.

Re-drawn from Perak Land Alienation Map (Kuala Lumpur, 1952). By courtesy of the Surveyor-General, Federation of Malaya.

It has already been shown that practically all the Kinta Valley is stanniferous. The upland limit of 250 ft. beyond which mining is restricted coincides with the normal boundary of rubber planting. This foothill zone contains the richest ore deposits and, consequently, on both sides of the valley it is used almost exclusively for the more lucrative proposition of mining rather than for rubber, which entails an initial period of six or seven years without returns. With the introduction of dredging, mining has also been gradually encroaching on to the alluvial flats in the lower parts of the valley, while the acute shortage of ore reserves has even led to the serious consideration of land at present used for urban development as potential mining fields. The situation has ceased to be a laissez-faire contest between agricultural and mineral forms of land-use, for Government policy seems to favour the eventual exploitation of all mineralized areas in the Kinta Valley. But it is also part of that policy subsequently to restore mined land to a condition suitable for the practice of agriculture.

Reclaiming Mined Land

The difficulties of reclaiming mined land for agriculture vary with the type of mining methods used. Where land has been worked open-cast, whether for gravel-pumping or hydraulicking, the resultant landscape has a hummocky appearance and consists of a series of abandoned mining pits, generally filled with water. It is usually difficult and economically impracticable to restore such land to its original level state by filling up these holes, although in places these pits have been filled with tailings discharged from neighbouring mines. This serves to restore the land as well as to absorb effluent that otherwise would find its way into the drainage system of the region. One such example is the Simpang-Ampat slimes filling scheme, near Ipoh. Land worked by open-cast methods usually has a barren appearance, resembling in parts a karstic landscape with pinnacles and depressions. On such land, denuded of its forest cover and often consisting of unconsolidated material, erosion is extremely rapid, especially where the mining site is situated on a steep slope. A good example of such erosion is to be found just outside Sungei Siput town, on the main road to Ipoh, where the landscape resembles a desert 'badland' in miniature. Although coarse vegetation in time establishes itself on such land, the process of regeneration is so slow that the earth remains in a barren condition for many years. The possibility of future agricultural utilization of land worked over by monitors is remote, unless market-gardening can be undertaken on a small scale by mine labourers. Even then intensive manuring will be essential for good yields.

More than half the total production of tin-ore in Kinta in 1952 was obtained by dredging. The effect on the landscape of this mining varies with the type of dredge used, but two points should be borne in mind: (1) dredging is at present confined to flat, alluvial, swampy land that has until recently been agriculturally unproductive. It has been used neither for padi cultivation nor for the planting of cash crops. Hence, in the past dredging in the Kinta Valley has not usually encroached to any great extent upon agricultural areas. (2) dredging sometimes has a constructive effect on the landscape, as, for example, when it improves the drainage condition of a swampy region. The land between Malim Nawar and Tanjong Tualang and downstream from Tanjong Tualang, for example, was undeveloped swamp before dredging was undertaken in the locality. Although earlier mining up-stream may have raised the water-level as a result of silting, the operations of dredging companies so cleared and drained the land that large parts are now suitable for cultivation.

During the course of a dredging operation, a large volume of alluvium from 50 to 150 ft. in depth passes through the various stages of treatment from puddling to the final concentration of the ore. The residual product of waste material is then discharged over the end of the dredge. The dredge floats in a *paddock*[1] of its own making and moves

1. The miners' term for the pond excavated by the dredge.

forward slowly as the excavation progresses, while the discharge of worked-over effluent fills up the rear portion of the pond. On first inspection, therefore, the worked-over land has much the same appearance as it had before mining began except that the ground is now bare of vegetation and a pond marks the final area of operations. This impression is misleading, however, for a closer scrutiny shows that the ground is not level but hummocky, and where stackers have been used, the surface is irregular and diversified by hillocks and ridges of pebbles and stones. Moreover, because of the rules and regulations governing the disposal of mining effluent, dredging companies often find it necessary to accumulate slimes in separate paddocks, so that the worked-over surface then includes a series of small, flat terraces at varying levels.

The indiscriminate treatment of ground up to 150 ft. in depth results in the upper layers of agriculturally valuable land, including the soil, being mixed with barren subsoil, regolith and parent rock. Whatever humus may be present in the soil is thus lost. Sir Lewis Fermor draws attention to this effect of dredging in the following paragraph. "In addition the dredge, as a necessary part of its operations, effects a separation of the coarser materials such as boulders, pebbles and sand, from the finer material, usually known, when in suspension, as slimes. Further, unless special measures are taken, the tendency is for the slimes resulting from dredging to be covered by the coarse materials. The slimes contain practically the whole of the clay materials of the original ground. The result of dredging in many cases is, therefore, not only the general admixture of the more fertile surface portions with the less fertile ground below, but the final rearrangement of materials, so that the less cultivable sand overlies the more cultivable clay"[1]. Where the opposite process occurs, that is, where the fine material is deposited above the coarse, the ground is left in a condition somewhat more conducive to the regeneration of vegetation, and constitutes a better medium for the formation of humus. But this is not a common practice and has occurred only incidentally. The final order in which the tailings from a dredge are deposited is dependent upon the design of the dredge, which in turn is chosen according to local ground conditions. Thus, when fine slimes have been laid over coarse, it has been the result not of any altruistic intent on the part of the mining companies, but rather the accidental outcome of what they consider to be the most effective scheme of operations. According to Fermor's investigations, the minimum thickness of silt necessary for the restoration of dredged land to agriculture is two feet or, on very porous soils, three feet. But it has not been definitely established what the optimum depth of slimes should be for any particular agricultural purpose, or to what extent this optimum depth may vary with the type of soil mined.

An alternative method of reconditioning mined land is to allow the periodic inundation of dredged areas by flood waters from rivers in spate. The land then benefits from the deposition of alluvium in the same way as do the flood-plains of rivers in, say, Siam[2]. However, there is a major obstacle to the adoption of this method in Kinta. Although most of the land undergoing dredging is below flood level, one of the conditions of the Kinta River Deviation Scheme is that the diversionary works must incorporate berms designed specifically to prevent the overflow of flood-waters.

In the recovery of tin-ore by dredging all the organic matter in the original soil is lost, and the fine slimes jettisoned by the dredges contain very little vegetable matter, so that there is practically no humus in the soil of a newly dredged area. Such land is, therefore, of little value agriculturally. The natural succession of plant regeneration will eventually induce sufficient fertility to support a moderately good plant growth, but not for more than a century will this process be complete[3]. The core of the problem is to discover the types of

1. Fermor, op. cit., p. 150.
2. *Federated Malay States' Chamber of Mines Year-Book, 1940* (Kuala Lumpur, 1940), p. 241.
3. F. Birkinshaw, "Reclaiming Old Mining Land for Agriculture," *Malayan Agricultural Journal*, vol. 19 (Kuala Lumpur, 1931), p. 470.

plants that will accelerate the process. The rapidity with which plants are able to establish themselves on mined land depends not only upon the nature of the soil, but also upon the water supply. On unslimed, sandy areas, natural regeneration is extremely slow and several years elapse before the ground is covered with even a stunted growth of vegetation; but in slimed areas the process takes place more rapidly and a larger range of plants is able to establish itself. On such soils a number of indigenous, as well as certain imported species, have been pròved to do well under experimental conditions. Among the indigenous plants are the tall grasses such as *Saccharum* (Malay: *Teberau*), *Coelorrhachis*, *Phragmites* (Malay: *Gedabong*) and bamboos, as well as such ubiquitous species as *lalang* (*Imperata cylindrica*), buffalo grass, carpet grass, *Eragrostis* and *Digitaria*. Under swampy conditions the water-loving grasses such as *Isachne australis*, *Hymenachne myurus*, *Panicum repens*, and certain reeds and sedges have been proved to do better[1].

Padi Experiments

In 1923 the Agricultural Department of the Federated Malay States and the Mines Department jointly conducted field-trials in Kamunting and Batu Gajah to discover the best means of growing green dressings to supply organic matter to slimed land. It was found that the land always had to be drained thoroughly before any vegetation could establish itself. Of the eleven plants that were tried, only four were found to be suitable for the purpose: *Mimosa invisa*, *Tephrosia candida*, *Crotalaria usaramoensis* and *Crotalaria striata*. "It was ascertained that Mimosa invisa would cover the land completely with a dense growth if sown in clumps at $6' \times 6'$. Tephrosia candida was slower in becoming established, but thereafter maintained a good growth. A satisfactory planting distance was found to be in clumps of $4' \times 4'$ . . . Crotalaria usaramoensis proved the most promising plant of this genus"[2].

During the 1930–1 season, the plots of land previously sown to green dressings were ploughed and irrigated for padi cultivation. The experiments proved that padi plants would grow well on dredged land that had been covered with 1½–2 ft. of slimes, provided the organic content of the soil was first replenished by green dressings that had been allowed to grow for at least three or four years before ploughing took place. But the experiments did not establish that the plants would necessarily produce good crops of padi, mainly because both plants, tillers and ripened grain were attacked by pests. Birkinshaw's conclusion was that, "It cannot yet be definitely claimed that the poor production of grain was not to some extent due to the influence of the soil. This point can only be conclusively settled by further experiments"[3].

Further light was thrown on this question when data collected during the 1946–7 season from six localities in Kinta[4] were made available. In some of the areas, sliming had taken place as long ago as 1937–8, and in all localities the padi crops were the fourth consecutive ones to be harvested. The results were encouraging, for the average yield per acre varied from 200 to 260 *gantangs*[5], in contrast to the 180 *gantangs* per acre obtained for the State of Perak as a whole during that season, and 210 *gantangs* for the Peninsula[6].

The problem of reconditioning old mining land for agriculture is still awaiting solution, for the experiments were not conclusive and were on too small a scale to be of much significance. There are isolated instances of dredged land being put to other types of use, viz., the growing of coconuts on the property of *Tronoh Mines Limited*, and more commonly, with intensive manuring, of market-garden produce, while Chinese squatters in parts of the Kinta Valley often combine work as labourers in mines with the part-time occupation

1. *Report on Rivers in the F.M.S.*, Appendix M, p. 172.
2. Birkinshaw, op. cit., p. 472.
3. Birkinshaw, op. cit., p. 476.
4. 600 acres in the Ipoh, Batu Gajah, and Kampar sub-districts.
5. One *gantang* of unhusked padi = 5 lb. (approx.).
6. *Malayan Union Annual Report of the Mining Industry for the Year 1947* (Kuala Lumpur, 1948), pp. 64–5.

of vegetable-growing[1]. The possibility of restoring land mined by open-cast methods, for reasons given above, is remote; the only type of land that can be reconditioned satisfactorily is that which has been dredged, but here again restoration for agriculture or for other purposes is dependent upon many factors, not the least of which is the implementation of a scheme of conservation designed primarily for that purpose.

Mining and Forestry

Before controls were imposed mining resulted in the deforestation of vast tracts of countryside. This was caused not only by the clearing of the natural vegetation on the mining sites, but more especially by the indiscriminate felling of large areas of forest around the mining locations. Before the establishment of smelting works at Penang and Singapore, the miners used to smelt the ore they produced on the spot, and they soon found that hardwoods provided the best type of fuel[2]. The Malayan rain-forest is characterized by a profusion of species, and there are usually no more than a few scattered trees of any one type in any given area. Consequently there was a great wastage of valuable wood during the period when smelting was done locally, as large tracts of forest were cut down in order to extract from them the isolated species of hardwood trees suitable for charcoal production. The demand for timber was not exhausted with the use of hardwoods for charcoal production, for the miners also depended to a large extent on local forests for supplies of poles and of timber for gangways, scaffoldings, *lanchutes*, communal living quarters and many of the other features seen in a mining landscape. With the introduction of machinery the forests were further denuded of hardwoods to be used as fuel for the engines employed in the mines. The consequences of this denudation were all the more serious because mining was concentrated on hill-sides and undulating land. Thus erosion was accelerated on slopes formerly protected by a mantle of natural vegetation.

No protective measures were taken until as late as 1887, when the Government decided that the loss of valuable timber could be minimized by introducing a new type of furnace using only ordinary firewood instead of valuable hardwood. *Order in Council No. 4 of 1887* enforced the use of this new furnace which was called the *Relau Tongka*[2]. Further restrictions on the cutting of timber and on smelting were imposed by *Orders in Council Nos. 6 and 7 of 1888*. With the general introduction of the *Mining Code* in 1895 the Government acquired greater authority over operations, and a stricter control was exercised to prevent damage in any form. It was suggested, for example, that fees for charcoal licences should be raised in order to discourage local smelters from cutting timber. Also in 1886 the firm of *Sword and Mhulinghaus* was formed in Penang. This concern provided miners with smelting facilities for their ore, and with the rapid improvement in transport in later years, gradually induced more and more companies to send their ores to Penang to be smelted. Finally, ores were no longer worked in the local furnaces but were sent to Penang or Singapore. But this process was not completed overnight, and the Chinese smelters for some time continued to draw off some of the supplies of local ore, especially those that were of lower grade. The position was summarized succinctly by the Resident of Perak in his annual report for 1896. "To entirely prohibit charcoal burning, as has been advocated, and to shut down the Chinese smelting *kongsis*," he said," would create a monopoly for the one European smelting company, and as that company declines to deal with the lower and more refractory grades of ore, there would be no market for such ores, and the State would be the loser"[3].

1. Ibid.
2. Everitt, op. cit., p. 24.
3. W. H. Treacher, *Perak Annual Report for 1896* in *Dispatches from the Secretary of State, 1896*, p. 20.

Forest Reserves

About 38 per cent of the 274 square miles comprising the Kinta District is reserved forests,[1] and a large part of this reserved area is also stanniferous. Forested highlands, which constitute the main reserves, are at present exempt from the destruction consequent upon mining, the normal upper limit for which is the 250 ft. contour, but there are two reserves in the lower parts of the Kinta Valley: the Parit Reserve constituted in 1901, and the Tanjong Tualang Reserve constituted in 1904. These, together with two other reserves in the Batang Padang district, total 108,000 acres and have been annually the source of over 30,000 tons of timber, poles, and fuel—forest products which have found a ready market in the mines of both the Kinta and Batang Padang valleys. Originally the highlands were set aside for silviculture and regarded as permanent sources of timber and other forest products, but since the nineteen-thirties they have been the object of envious attention from mining interests which, with rapidly diminishing ore resources, have demanded the opening of the reserves to mining claims.

The cost of timber depends very largely upon the cost of transport, and hence on the accessibility of the source of supply. The Forest Department is, therefore, interested in the development of those forests adjacent to lines of communication, which in Kinta have been built to connect mining areas. In the early days of settlement the establishment of forest reserves on stanniferous lowland areas met with no strenous objections, mainly because mining land was abundant. Ore reserves that are now being, or have already been exhausted, were in the first decade of this century considered sufficiently extensive to sustain mining until new resources should have been brought into production. But since the nineteen-thirties prospecting has been almost at a standstill (see p. 31), while existing reserves have been drawn on continuously. The problem became acute as early as 1938, when there were sudden demands that extensive forest reserves, then being developed intensively, should be opened to mining. Clearly, the choice rested between a form of land use on the one hand which though financially less remunerative than mining, was based on sound conservation principles, and which afforded a permanent annual yield of timber, poles and fuel, and on the other hand, a destructive exploitation which resulted in the obliteration of the forests as well as the deterioration of the soil.

There is no private ownership of minerals in Malaya; they all belong to the State, but the right to sanction prospecting in Forest Reserves is a prerogative of the Forest Department which, under the provision of the *Forest Enactment* (*Cap. 153*) controls "the search for, collection, subjection to any manufacturing process, or removal of any forest produce or minerals" (*Section 20 d*). Under *Section 16*, mineral rights can be given only by the Resident of the State after consultation with the Forest Officer. The arguments for the deforestation of reserves and their opening up to mining alienation were based mainly on financial considerations, but after repeated representations by the Chamber of Mines, a *Regional Planning Committee* was appointed in the State of Perak in 1938. Its terms of reference were: "To examine the question of the delimitation of mining areas in the State of Perak, with a view to reconciling the divergent interests of mining, agriculture, and forestry and to advise as to the steps which ought to be taken to determine the situation and extent of potential tin-fields outside existing mining areas and the possibility of their exploitation"[2].

The arguments for the reservation of forested land for silvicultural and other purposes were summarized in the *F.M.S. Annual Report on Forest Administration* for 1937:

(*a*) . . . it is realized that the prosperity of this country is largely founded on tin, and that, where it exists in payable quantities, ordinary forestry must sooner or later give way to mining. The Department has always been ready to relinquish

1. *Annual Report of the District of Kinta, 1948* (Batu Gajah, 1949).
2. *F.M.S.Chamber of Mines Year-Book, 1938*, p. 290.

areas of low-grade swamp forest and in the valley seeks to retain only the valuable forests under intensive management, which are required for the permanent timber supply of the country and on which large sums of money have been spent. It is at least arguable that where tin is present in forests of this class no mining should be allowed, at any rate until timber in them has reached maturity[1].

(*b*) . . . Very little forest remains on State land in these districts (i.e. Kinta and Batang Padang), the area is shrinking rapidly, and the native population is becoming more and more dependent on reserved forests to supply its needs . . . The interests of the mining community must obviously be considered, but the needs of the Malay small-holder and other members of the community must likewise not be forgotton[2].

(*c*) . . . Forestry is a long range business that demands security of tenure and of all forms of production is the least capable of adjustment to suit rapidly changing conditions. It is necessary, therefore, that there should be a guarantee of permanence in respect of the area required for intensive treatment, without which work could not be organized on economical lines[3].

To meet the demands of the mining industry in Perak, the Forest Department eventually opened up some 45,000 acres of reserved forests to general prospecting, and agreed to surrender any land within them which proved to be stanniferous[4].

The problem of conserving forest resources is closely connected with that of the eventual exhaustion of proved reserves. The possible migration of mining to upland areas as yet unworked would occasion a new set of difficulties consequent upon the change from a technique adapted to shallow alluvial deposits to that of lode mining, found in Malaya at present only in isloated instances. Forest conservation would then be a more difficult matter, for the consequences of the clearance of vegetation are more serious in uplands than in lowlands. Most of the upland forests have been reserved mainly for protective rather than silvicultural purposes, and destruction of this cover would have repercussions not only on the drainage system of the country but also indirectly on other types of land use in the valley. On the other hand, lode- and shaft-mining will have less devastating effects on the landscape than the shallow, but extensive, techniques now employed.

1. (*F.M.S.*) *Annual Report on Forest Administration, 1937*, p. 3.
2. ibid.
3. Op. cit., p. 4.
4. *Annual Report on Forest Administration, 1937*, p. 4.

CHAPTER VII

POPULATION DISTRIBUTION AND RESETTLEMENT

EARLY IN 1948 a state of emergency was declared in Malaya, a measure which had severe repercussions on the mines of the Kinta Valley. "The strategy of the terrorists . . . was to strike at the vitally important tin and rubber industries, bring production to a standstill and thereby reduce the economic life of the country to chaos. Attacks were concentrated on the estates and mines and . . . directed primarily against the management in the hope of disrupting the labour forces in general"[1]. These armed attacks did not cause tin production to cease entirely, although there was an initial decline in production until defences could be set up round the mines. Mine staffs, especially the executives, had to be protected by the police and normal movements at fixed times between house and mine were frequently interrupted by ambushes. Many mines remote from urban areas were, in fact, forced to close down.

At this time the landscape around each mine underwent considerable change. Before the emergency, the mines were unfenced and the scattered wooden houses of the labourers had an air of impermanence, a reflection of the nature of Kinta mining, which necessitates a shift in location as one site is exhausted and another is opened up[2]. Each mine is now surrounded by a barbed-wire fence with watch-towers, and the formerly dispersed houses of the labourers have been regrouped inside the perimeter. Squatter groups who, during the Japanese period, had illegally occupied restricted areas in and around the mines, have meanwhile been resettled in entirely new villages. Thus, the settlement pattern of the Kinta Valley is now characterized by a greater degree of nucleation and permanence.

THE URBAN POPULATION

Slightly more than half (51 per cent) of the total population of Kinta in 1947 was classified as urban, i.e. was located in towns and villages with a resident population of over 1,000 each[3]. All other people outside these areas were classed as "rural". This degree of urbanization was double that of Malaya as a whole in 1947, but it would have been still higher if peripheral dormitory and food-supplying suburbs had been included in the category of urban.

This population was distributed in fourteen towns (Table 5), situated cheifly on the main roads which run longitudinally along the foothills of both the Kledang and Main Ranges, that is, in close proximity to early mining sites. These two road systems converge at Ipoh, which is also the focal point of rail transport, and was in earlier years a terminus of river transport. Three towns, Batu Gajah ,Tanjong Tualang and Malim Nawar occupy the central parts of the lower valley, which is now the focus of dredging activity. The overall pattern may be likened to an inverted V, with Ipoh at the apex. (Fig. 11A). This pattern of urban population evolved in response to the labour demands of the mining industry. Population growth in Kinta resulted mainly from the influx of large numbers of immigrants from South China, who at first made their way into the region from the port of Telok Anson. Between the years 1879 and 1894. the net immigration into Telok Anson was 103,328 (Table 6). With the completion of overland communications into the Kinta Valley

1. *The Fight against Communist Terrorism in Malaya* (London, 1951), p. 10.
2. The amorphous pattern of these mining settlements shows clearly on maps of the Malayan One-Inch-to-One-Mile Series, *Hind 1035*, Sheets *2N* 1, 5, 9, 13 and *2M* 4, 8, 12 and 16 (Third Edition).
3. M. V. del Tufo, *A Report on the 1947 Census of Population* (London, 1949), Table 3, p. 164.

the Telok Anson route was supplemented by road and rail from Penang and Larut. This movement of Chinese into the mines, and later of Indians on to rubber estates, continued until late in the nineteen-thirties, when immigration was restricted to an annual quota. Until then the size of the population fluctuated with the price of tin. Higher prices attracted Chinese workers, a depression halted immigration or even caused a movement outwards; while the Malays formed only a small indigenous group. The total outcome, however, was a substantial net gain in population.

TABLE 5: POPULATION AND RACIAL COMPOSITION OF TOWNS IN KINTA, 1947

Town	Malays	Other Malaysians	Chinese	Indians	Europeans	Eurasians	Others	Total
Chemor	150	8	2,228	351	..	..	4	2,741
Ipoh	6,154	915	56,727	14,706	636	514	1,242	80,894
Jelapang	52	1	1,223	51	..	..	..	1,327
Lahat	63	1	1,320	63	..	..	1	1,438
Menglembu	122	5	9,142	465	1	..	16	9,751
Tambun	241	..	791	49	..	..	10	1,091
Tanjong Rambutan ..	1,178	90	2,769	1,343	8	9	56	5,453
Batu Gajah	1,785	22	3,359	2,038	157	20	99	7,480
Pusing	132	2	2,127	239	..	..	1	2,501
Tanjong Tualang ..	86	8	1,199	59	..	..	..	1,352
Tronoh	192	2	2,600	212	..	..	18	3,024
Gopeng	220	8	3,110	355	6	..	18	3,717
Kampar	720	39	14,765	1,819	19	13	124	17,499
Malim Nawar ..	219	1	1,792	388	..	4	4	2,408

Data from M. V. del Tufo, *A Report on the 1947 Census of Population* (London, 1949), Table 7.

TABLE 6: IMMIGRATION INTO TELOK ANSON, 1879–94

Year	Arrivals in Lower Perak	Departures from Lower Perak	Excess of arrivals over departures
1879	1,403	637	766
1880	1,993	465	1,528
1881	3,411	2,071	1,340
1882	7,365	3,120	4,245
1883	7,738	4,102	3,636
1884	10,163	8,021	2,142
1885	10,581	1,755	8,826
1886	17,439	11,260	6,179
1887	21,841	10,387	11,454
1888	29,114	12,618	16,496
1889	9,085	5,470	3,615
1890	22,590	19,135	3,455
1891	21,108	10,585	10,523
1892	23,515	16,373	7,142
1893	29,518	14,589	14,939
1894	23,515	16,373	7,142
16 Years	240,389	137,061	103,328

Compiled from data in the *Perak Annucl Reports*, 1879–94.

TABLE 7: POPULATION OF KINTA, 1879–1947

Year	Males	Females	Total	Percentage increase over preceding period
1879	5,031	3,829	8,860	..
1891	49,654	8,933	58,587	661.25
1901	103,234	19,503	122,737	109.49
1911	143,206	41,487	184,693	52.46
1921	125,327	59,960	185,287	0.30
1931	159,896	90,662	250,558	35.20
1947	151,466	129,990	281,456	11.21

Compiled from the *Census Reports* of the Federated Malay States, 1891, 1901, 1911, 1921 and 1931, and del Tufo, op. cit.

The early development of Kinta was characterized by a mushroom growth of mining camps. Some of these disappeared when the ore in their proximity was exhausted, but others persisted and grew into towns. In its prevailing atmosphere of instability and discontinuity the scene was reminiscent of the days of the American and Australian gold rushes. Because there appeared to be no limit to the ore available in the valley miners could pick and choose their sites, and their primitive techniques led them to work only the richest deposits. As soon as water flooded the mines or returns began to diminish they moved to new areas. There was thus a constant migration of mining villages.

Among the earliest settled areas in Kinta were those of Gopeng and Papan, lying almost latitudinally opposite each other on either side of the valley. Around Papan there developed minor nucleations at what are now Pusing, Lahat, Sorokai, Tekka-Pengkalen, Pegu, Menglembu, Selinsing and Klian Padang. Tekah and Kampong Sungei Raia took shape later near Gopeng[1]. Kampar, among the eastern foothills of the Bujang Malaka granite mass, had only thirty Chinese in 1877[2]. Tin was discovered there in 1891, and within two months the place became "a large and flourishing mining village with 154 shops in it laid out in 60 foot streets". A rush to this part occurred and over 1,000 acres of mining land were taken up[3]. In 1947 this town had a population of 17,499, with mining still its main economic activity. Ipoh, now the capital of Perak, occupied a central location in relation to lines of transport. It had been connected with mining since the early days, for around its outskirts were the rich stanniferous lands of Tambun, Jelapang, and Menglembu. In 1889 its population was 2,000; by 1947 it had risen to 80,894. Batu Gajah, which later became the administrative headquarters of the Valley, had its beginnings as a depot and river port connecting Telok Anson with the mining localities of Gopeng and Papan[4]. It has since become a centre of dredging, and in 1947 had a population of 7,480. Tanjong Tualang and Malim Nawar are dredging centres which have developed more recently.

1. De la Croix, op. cit., pp. 4–5.
2. *Straits Daily Times*, 18 August, 1887.
3. *Kinta Monthly Report for September, 1891*, in the *Perak Government Gazette, 1891*.
4. See p. 23 above.

The Rural Population

In 1949 the bulk of the rural population in Kinta was made up of a total of some 94,000 squatters. Of these, 89,900 were settled on actual or potential mining land or on worked-over ground[1]. Discontinuity was the hallmark of these squatter settlements on mining land, for they had to shift when the land was needed for mining or when the men obtained work in remoter mines. The census of 1947 showed the total population of Kinta District as 281,456. Allowing for an increase in this figure between 1947 and 1949, by the latter date the squatters must have constituted one-third of the total, or two-thirds of the rural, population. The remaining third was scattered in Malay reservations, on agricultural holdings and rubber estates. There were also the villages of Kanthan (pop. 580 in 1947), Kopisan (pop. 421), Papan (pop. 763), Siputeh (pop. 680), and Kota Bharu (pop. 371), all classified as 'non-urban'.[2].

This rural squatter population began to appear during the Great Depression of the nineteen-thirties, when there was an exodus of Chinese immigrant labour from mines which had closed down. The unemployed miners then turned to the land for a livelihood, setting up huts and cultivating a few acres on estates, on Government land and near mines. They later provided a cheap and handy pool of unskilled and semi-skilled labour when mines were re-opened, and in the meanwhile the vegetables, poultry and pigs which they produced on their small-holdings were some guarantee against starvation in times of depression.

The Japanese occupation induced another major dislocation of labour throughout Malaya as rubber and tin production came almost to a halt. As food became scarce many people left the towns, the estates and the mines to live in rural areas, where they cleared land, cultivated some food crops and enjoyed the advantages of isolation at that dangerous time. Those that turned to uncultivated land were pioneer settlers, distinct from the squatters on urban margins, who were engaged in only part-time cultivation and eked out a living as casual labourers. A third class of squatters was that on mines and estates. These built their houses on land already alienated[3]. Their distribution over the valley was not characterized by any distinctive settlement pattern, although some of them formed loose nucleations around the mines.

When completed in 1952, resettlement of the squatters had effected a major change in the settlement pattern discussed above. The aim of this measure, dictated by military policy, was to concentrate squatters in compact units enclosed by barbed-wire barricades, so that they could be brought within range of effective administrative control, while they were at the same time insulated and isolated from the guerillas. This enforced redistribution of population involved two processes:

(1) *Regrouping*, defined by the authorities as the concentration of squatters into a village by removal of their houses to a new site. By this expedient they neither lost the use of their existing holdings nor were forced to change their usual place of work.

(2) *Resettlement*, defined as the shifting of squatters to a new village, often remote from their existing holdings or other forms of occupation. This meant a change from their previous mode of life, and entailed the abandonment of their holdings, crops and houses. As a consequence of the re-location of squatters thirty new towns and villages have been created in Kinta (see Table 8 and Fig. 11B). The sizes of these villages vary; 400 houses is now considered by the authorities to be the optimum unit for administrative purposes.

1. *Report of the Perak State Squatter Committee* in *Proceedings of the State Legislative Council, 17 Feb., 1949*, p. 6.
2. del Tufo, op. cit., Table 7, p. 163.
3. See also E. H. G. Dobby, "Recent Settlement Changes in South Malaya", *The Malayan Journal of Tropical Geography*, Vol. 1 (Singapore, 1953), pp. 2–3.

Villages containing more than 400 houses, such as Sungei Durian, which had 788 houses in 1952 and a total population of 4,412, have been found too large for efficient administration; villages of less than 200 houses, such as Chendrong, on the other hand, are unnecessarily costly in relation to their size[1].

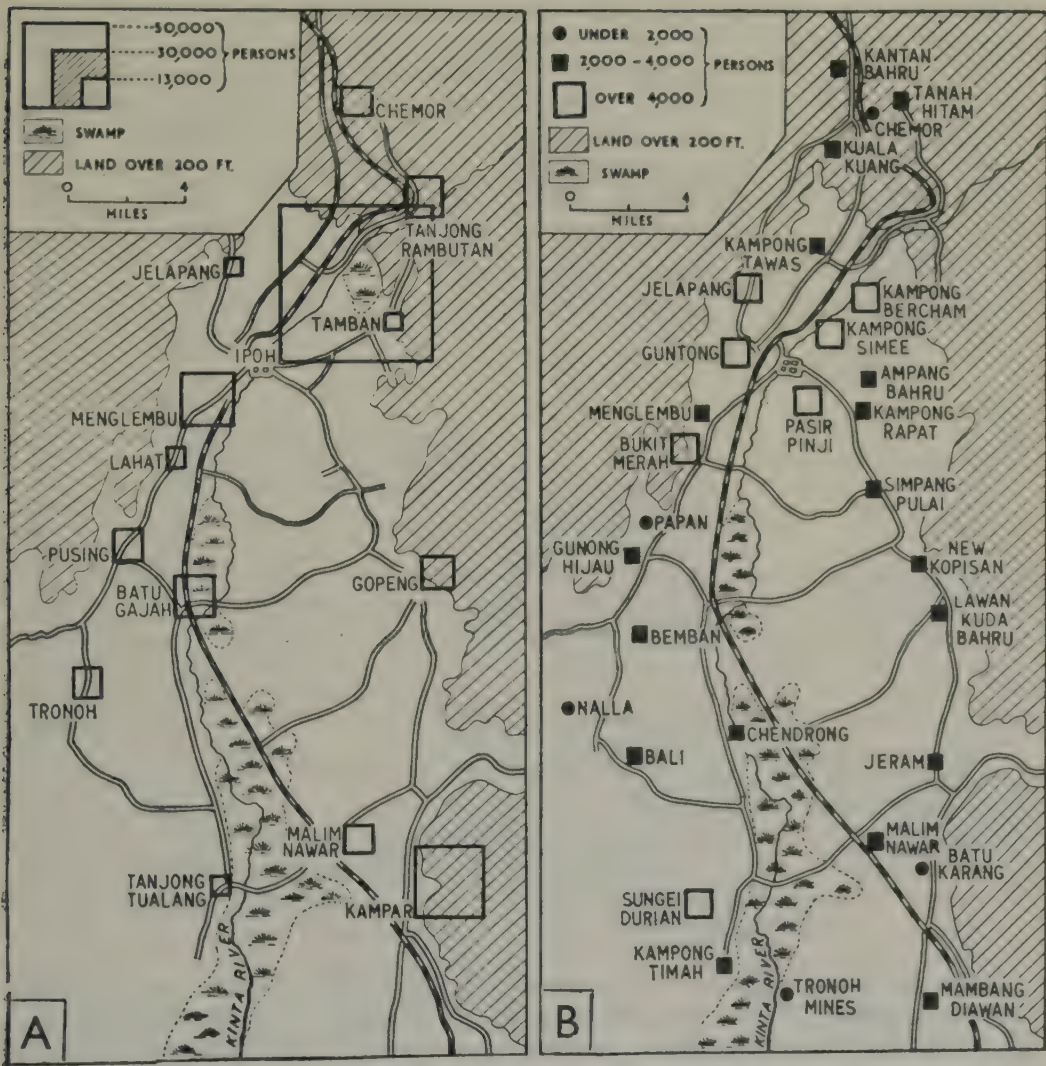

Fig. 11. Settlement changes in the Kinta Valley, 1947/52.

A. Towns and villages in 1947. Reproduced from E. H. G. Dobby, "Recent Settlement Changes in the Kinta Valley", *The Malayan Journal of Tropical Geography*, Vol. 2 (March 1954), p. 62.

B. New settlements, 1952. Based on data supplied by the District Officer, Kinta. Roads and railways are depicted as in Fig. 7.

1. This account of the new settlements in Kinta is based on surveys undertaken in 1952 by Lee Yong Leng and Lee Khee Yoon, of the Department of Geography of the University of Malaya.

TABLE 8: RESETTLEMENT VILLAGES IN KINTA DISTRICT, 1952

———	Position	Nearest Town	Population
Ipoh Sub-District			
1. Ampang Bharu ..	1 mile west of Ampang	Ipoh	2,500
2. Bukit Merah ..	1½ miles north of Lahat	Lahat	6,500
3. Changkat Kinding ..	12 miles from Tg. Rambutan along Tg. Rambutan/Chemor Road ..	Chemor	250
4. Guntong	1 mile west of Ipoh	Ipoh	6,500
5. Jelapang	4 miles Jelapang/Ipoh Road	Ipoh	5,000
6. Kg. Bĕraham ..	2½ miles south-west of Tanjong Rambutan	T. Rambutan	4,205
7. Kg. Rapat	3¼ milestone Gopeng Road	Ipoh	3,000
8. Kg. Simee	1 mile north of milestone 2 Tambun Road	Ipoh	4,179
9. Kg. Tawas	4½ milestone Ipoh/Chemor Road ..	Ipoh	2,175
10. Kantan Bharu ..	11 milestone Ipoh/K. K. Road ..	Chemor	3,282
11. Kuala Kuang ..	Near 11 milestone Jelapang Road ..	Chemor	2,704
12. Pasir Pinji	1½ miles south of Ipoh	Ipoh	6,840
13. Tanah Hitam ..	14 milestone Chemor/Tanjong Rambutan Road	Chemor	2,530
14. Tebing Tinggi ..	¼ mile Jalan Bendahara	Ipoh	485
Batu Gajah Sub-District			
15. Bali	5 milestone Tanjong Tualang/Tronoh Road	Tronoh	2,335
16. Bemban	2 miles south-west of Batu Gajah ..	Batu Gajah	2,100
17. Chenderong ..	17 milestone Batu Gajah/Tg. Tualang Rd.	Batu Gajah	2,000
18. Gunong Hijan ..	Adjacent to Pusing	Pusing	3,870
19. Kg. Timah	26 milestone Changkat Tin Road ..	T. Tualang	2,350
20. Nalla	1 mile west of Tronoh	Tronoh	1,890
21. New Kopisan ..	10 milestone Gopeng Road	Gopeng	2,365
22. Sikh Settlement ..	Malim Nawar	T. Tualang	140
23. Simpang Pulai ..	7 milestone Gopeng Road	Ipoh	2,080
24. Sungei Durian ..	1½ miles south-west of T. Tualang ..	T. Tualang	4,450
Kampar Sub-District			
25. Batu Karang ..	21 milestone Ipoh/Kampar Road ..	Kampar	1,310
26. Jeram	Adjacent (north) of Kuala Dipang ..	Malim Nawar	2,135
27. Lawan Kuda Bharu ..	Kota Bharu Road, Gopeng: on Gopeng air strip	Gopeng	3,585
28. Mambang Diawan ..	3 milestone Degong Road	Kampar	3,575
29. Malim Nawar ..	Adjacent to Malim Nawar town ..	Malim Nawar	2,230
30. Tronoh Mines ..	Adjacent to Tronoh Mines village, 7 milestone from Kampar	Kampar	1,120

Compiled from data supplied by the District Office, Kinta.

The primary consideration in the choice of these new village sites was accessibility to lines of communication, both as a safeguard against attacks by the guerillas and as a means of contact with the administration. Hence the new villages, with one or two exceptions, are located on or near main roads, and usually also near towns. Their distribution thus follows closely both the lines of communication and the location of the towns in Kinta, and emphasizes a pattern which has already been established. The largest villages are sited on the periphery of Ipoh; others are near the towns on both flanks of the valley. The influence of mining on site selection is seen in the regulation preventing new villages in Kinta from being sited on land that had or was likely to have tin deposits. A site could be approved only if it was not in a Malay reservation or on alienated land. To find areas meeting both these exigencies was not easy, but abandoned mining land lent itself to the purpose. Bemban New Village, for example, is situated on land of this nature.

Re-location has thus had a two-fold effect on the population map of Kinta: (1) It has changed the settlement pattern of a large part of the rural landscape. The amorphous forms of the squatter settlements have been replaced by compact villages, whose house sites are laid out geometrically and enclosed by perimeter fences.

(2) It has induced a degree of urbanization that is probably unique in South-East Asia. In 1947 one in every two persons lived in a town of over 1,000 inhabitants: after re-location five in every six people. Re-location also emphasized the previous pattern of town distribution along longitudinal, north-south lines which follow the form of the valley.

Several of these new villages are situated within town board limits, so that they may be considered satellites of the towns. Table 9 shows these villages and their parent towns.

TABLE 9: RESETTLEMENT VILLAGES WITHIN TOWN BOARD LIMITS, 1952[1]

	Population of New Villages
Ipoh Sub-District	
1. Chemor Town	765
2. Tanjong Rambutan Town	935
3. Lahat Town	650
4. Menglembu Town	2,000
Batu Gajah Sub-District	
5. Papan Town	958
6. Papan Town (Sikh Settlement)	60
7. Batu Gajah Town (Indian Settlement)	655

THE EFFECTS OF RE-LOCATION ON MINING

Re-location has also induced considerable changes in the relation between the mining industry and its labour force. Although the labourers recruited from the squatter ranks are unskilled or at best semi-skilled, their large numbers make them an important component of the tin-mining economy. The decision to resettle them was in opposition to the recommendations of the *Perak State Squatter Committee* which was formed in 1948. This Committee recommended that, as a general rule, squatters on mining land should not be disturbed[2].

The disruption of labour relations came through resettlement and not through regrouping, which was only a removal of squatters to a defended site close to their place of work. Resettlement, on the other hand, posed the problem of how to replace the labour force disrupted when the squatters were moved. Nearly all the larger European tin companies solved it at their own expense by re-locating workers within the limits of their mining sites, but the rest had to suffer a period of temporary dislocation before they could obtain casual labour from the nearest new villages. More often than not this new labour was provided by squatters who were resettled near the mines, whilst many of those who had been working there previously found work nearer their new homes. The total effect was a shuffling and re-shuffling of labour between the mines. For example, of the 4,412 people in Sungei Durian New Village in 1951, only 41 per cent had been regropuped from the nearby Tanjong Tualang area; the remainder were brought in from Pusing, Tronoh, Siputeh, Kramat Pulai, Papan, Parit and Ulu Denak[3]. These squatters later filled vacancies in the mines near Tanjong Tualang.

Resettlement poses yet another problem. In earlier years, the re-siting of a mine at a new locality after the old one had been worked out was often followed by a corresponding migration of the mining squatters to the new site. Now this labour force, fixed within the

1. Data from the District Office, Kinta.
2. *Report of the Perak State Squatter Committee, 1949*, p. 12.
3. Lee Yong-Leng, Unpublished *Survey of Sungei Durian New Village* (August, 1952), p. 13.

perimeter of the new village, has lost its mobility. There are practical limits to the distance the squatter is able or willing to travel to a place of employment, and mines that are some distance away from the pools of labour in the new villages will have to find some means of overcoming this difficulty.

* * * * * *

In analysing some of the main problems and difficulties of mining in the Kinta Valley, we have at the same time traced the evolution of the valley landscape. The earlier phases of mining were characterized by the rapid and haphazard growth, and often by the disappearance, of settlements, as well as by indiscriminate mining practices which destroyed stretches of forest and caused excessive sedimentation of rivers. The discovery, at first by accident and subsequently by prospecting and survey, of the richest deposits of ore on the valley flanks, set the pattern of mining activity in the later phases. New and improved techniques were evolved and, with political stability established in the country, laws and regulations were introduced to minimize damage to the land. In the meanwhile the transport network was taking definite shape, with roads, running parallel to the valley sides. These factors together with the cessation of immigration in the late nineteen-thirties and the stabilization of the population, gave mining in Kinta an air of permanency which it had hitherto lacked. The latest phase in the shaping of the valley landscape came with the Emergency. The resettlement of squatters as part of a policy to end armed conflict, has given the population in Kinta a predominantly urban character and has materially altered the pattern of population distribution.

The problem set by the exhaustion of tin reserves is of long-standing; the search for and the working of new stanniferous areas has, through the encroachment of mining upon agricultural, riverine and forest reserves, effected widespread changes in the land-use map of the valley, If, with the ultimate exhaustion of the valley reserves, mining should migrate towards the primary ore of the uplands, a new set of problems will appear, and it is not unlikely that the Kinta landscape will eventually come to present a certain resemblance to that of the Bolivian Altiplano.

BIBLIOGRAPHICAL NOTE

1. Much of the information discussed above has been gleaned from scattered references in the archives of Raffles Museum, Singapore, especially from the *Annual Reports* of the Federated Malay States, the various Straits Almanacs and Directories, and also from the *Dispatches* from the Secretaries of State. There is also much useful material in local newspapers, notably *The Straits Times*, *The Penang Gazette*, *The Malaya Tribune* *The Straits Observer*, *The Singapore Free Press* and *The Straits Echo*. In addition I have made liberal use of the following reports, which are here arranged chronologically.

Blue Book of the Larut District in the Native State of Perak for the year 1874 (Singapore, 1874).

Annual Reports of Perak, the Federated Malay States, and the Federation of Malaya Departments of Agriculture, Fisheries, Forestry, Geology, Drainage and Irrigation, Mines and Railways, 1894–1953.

Annual Reports of the Kinta District, 1894–1953.

Report of the Mining Commission, Federated Malay States (Kuala Lumpur, 1901).

Report of the Tailings Commission, Federated Malay States (Kuala Lumpur, 1904).

Report of the Mining Commission, Federated Malay States (Kuala Lumpur, 1918).

Federated Malay States Chamber of Mines Year-Books, 1920–52.

Report on Rivers in the Federated Malay States (Kuala Lumpur, 1928).

Federated Malay States Road and Rail Transport, 1932, Enclosure No. 8 of 1932.

M. V. del TUFO, *A Report on the 1947 Census of Population* (London, 1949).

2. The following are general works, arranged in alphabetical order of the authors' names.

Fifty Years of Railways in the Federated Malay States, 1885–1935 (Kuala Lumpur, 1935).

British Empire Exhibition Series: *Malayan Series* (Singapore, 1924).

The Fight against Communist Terrorism in Malaya (London, 1951).

P. DOYLE: *Tin Mining in Larut* (London, 1879).

W. E. EVERITT: *A History of Mining in Perak*. [Typescript, 1952].

SIR LEWIS FERMOR: *Report upon the Mining Industry of Malaya* (Kuala Lumpur, 1939).

G. E. GREIG: *Mining in Malaya. Malay States Information Agency* (London, 1926).

W. T. HALL: *Report on Mining in Perak and Burma* (Rangoon, 1889).

HONG EU-NGOH: *Larut to Kinta*: *A Study of Tin Mining in Perak, 1874–95*. Unpublished B.A. (Hons.) thesis of the University of Malaya.

W. R. JONES: *Tinfields of the World* (London, 1925).

W. R. JONES AND J. B. SCRIVENOR: *The Geology of South Perak, Federated Malay States* (Kuala Lumpur, 1919).

C. C. LONGRIDGE: *Gold and Tin Dredging*, Third Edition (London, 1913?).

C. L. MANTELL: *Tin*: *Its Mining, Technology and Applications. American Chemical Society Monograph Series* (New York, 1949).

J. B. SCRIVENOR: *Notes on Prospecting for Tin-ore in the Federated Malay States* (Kuala Lumpur, 1911).

J. B. SCRIVENOR: *The Geology and Mining Industry of the Kinta District, Federated Malay States* (Kuala Lumpur, 1913).

J. B. SCRIVENOR: *The Deposits of Tin-ore in the Limestone of the Kinta Valley, Federated Malay States* (Kuala Lumpur, 1914).

J. B. SCRIVENOR: *The Geology of Malayan Ore-Deposits* (London, 1928).

J. B. SCRIVENOR: *The Origin of Tin Deposits* (Kuala Lumpur, 1909).

J. B. SCRIVENOR: *Tin-fields of the Federated Malay States* (London, N.D.).

C. E. WARNFORD-LOCK: *Mining in Malaya for Gold and Tin* (London, 1907).

R. O. WINSTEDT: *Malaya, the Straits Settlements and the Federated and Unfederated Malay States* (London, 1923).

L. WRAY, Jr.: *Alluvial Tin Prospecting* (Taiping, 1893).

3. The following is a selection of useful papers, arranged in chronological order.

H. W. C. LEECH: "About Kinta", *Journal of the Straits Branch of the Royal Asiatic Society*, vol. 4, (Singapore, 1879), pp. 21–33.

J. E. de la CROIX: "Some Account of the Mining Districts of Lower Perak", *Journal of the Straits Branch of the Royal Asiatic Society*, No. 7 (Singapore, 1881).

J. E. T. WOODS: "The Stream Tin-deposits in Perak", *Journal of the Straits Branch of the Royal Asiatic Society* No. 13 (Singapore, 1884).

A. HALE: "On Mines and Miners in Kinta, Perak", *Journal of the Straits Branch of the Royal Asiatic Society*, vol. 16 (1886), pp. 303–20.

R. A. F. PENROSE: "Tin Deposits of the Malay Peninsula", *Journal of Geology*, vol. 2 (1892).

L. WRAY, Jr.: "The Tin Mines and Mining Industries of Perak", *Perak Museum Notes*, No. 3 (Taiping, 1894).

W. T. SAUNDERS: "Tin-mining in the Straits Settlements", *Transactions of the Institute of Mining Engineers*, vol. 27 (1904).

J. B. SCRIVENOR: "Alluvial and Lode Tin in Malaya", *The Mining Journal*, vol. 78 (London, 1905).

W. T. SAUNDERS: "The Lahat Pipe in Perak" *Quarterly Journal of the Geological Society*, vol. 65. (London, 1909).

J. B. SCRIVENOR: "The Gopeng Beds of Kinta". *Quarterly Journal of the Geological Society*, vol. 68 (London, 1912).

J. B. SCRIVENOR: "The Geological History of Malaya", *Quarterly Journal of the Geological Society*, vol. 69 (London, 1913).

W. R. JONES: "Supposed Occurrence of Tin in Springs in Malaya", *Geological Magazine* (London, 1914), p. 537.

M. PARK: "Mining in the Malay States", *The Mining Magazine*, vol. 10, (London, 1914).

W. R. JONES: "Mineralisation in Malaya", *The Mining Magazine* (London, 1915).

W. R. JONES: "The origin of Topaz and Cassiterite in Malaya", *The Geological Magazine* (London, 1916).

W. R. JONES: "The Origin of the Secondary Stanniferous Deposits of the Kinta District, Perak, F.M.S., *Quarterly Journal of the Geological Society*, vol. 72 (London, 1916).

A. C. PERKINS: "Tin Dredging in the Federated Malay States, *F.M.S. Chamber of Mines Year-Book*, 1916 (Kuala Lumpur, 1916).

H. D. GRIFFITHS: "Bucket-dredging for Tin in the Federated Malay States", *The Mining Magazine* (Dec., 1916; Mar., 1917).

W. R. JONES: "Origin of Tin Deposits in Kinta" *Federated Malay States Chamber of Mines Year-Book* 1923, (Kuala Lumpur, 1923).

R. J. WILKINSON: *Papers on Malay Subjects*: *History of the Peninsular Malays* (Singapore, 1923).

R. H. RASTALL: "Geology of the Kinta Valley", *The Mining Magazine*, vol. 36 (1927).

H. E. BIRKINSHAW: "Reclaiming Old Mining Land for Agriculture", *Malayan Agricultural Journal*, vol. 19 (Singapore, 1931).

G. H. HUTTON: "The Evolution of the Tin-mining Industry", *Federated Malay States Chamber of Mines Year-Book, 1931*, (Kuala Lumpur, 1931).

E. S. WILLBOURN: "A Short Account of Those Tin Deposits in Kinta that are Mined by Alluvial Methods", *Journal of the Mining Association of Malaya*, vol. 4 (Kuala Lumpur, 1936).

O. B. WILLIAMS: "A Brief History of Malayan Dredging", *Journal of the Mining Association of Malaya*, vol. 4, No. 4 (Kuala Lumpur, 1937).

A. KING: "Changes in the Tin-Mining Industry of Malaya", *Geography* (Manchester, 1940), p. 130.

E. S. WILLBOURN: "Notes on Tin Deposits in Malaya", *Federated Malay States Chamber of Mines Year-Book, 1940* (Kuala Lumpur, 1940).

4. The terrain of the Kinta Valley may be studied conveniently on the following maps:

Quarter inch to one mile, *Hind 1076*, Sheets *2M* and *2N* (First Edition).

One inch to one mile, *Hind 1035*, Sheets *2N1*, *2N5*, *2N9*, *2N13*, *2M4*, *2M8*, *2M12 and 2M16* (Third Edition).

THE MALAYAN JOURNAL OF
TROPICAL GEOGRAPHY